A STUDY OF SCHEMES OF LOGICAL THOUGHT AMONG CERTAIN GROUPS OF UGANDAN ADOLESCENT PUPILS WITH SPECIAL REFERENCE TO QUANTITATIVE KNOWLEDGE

THESIS

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CERTIFICATE

This is to certify that Mr. Nyangua Ephraim Kasekia has carried out a revision of his thesis entitled : A Study of Schemes of Logical Thought among Certain Groups of Ugandan Adolescent Pupils with Special Reference to quantitative Knowledge, as required by one of the external examiners, under my guidance. Para 5 of the examiner's report conveyed to me by the University runs as follows :

> "The major technical flaw in the thesis is that the results appear to have been tabulated using the 50% level of significance. The traditional levels employed in Psychology and Education are 5% and 1%. This should be corrected and the discussion of the results amended accordingly."

All necessary corrections required and those arising out of computerised work, as well as, misspelt words stand corrected. The discussion of the results has been amended accordingly. These have been personally checked by me.

The thesis is therefore being resubmitted for approval.

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C E R T I F I C A T E

I am pleased to certify that Mr. Nyangwe Ephraim Kosokia has worked on the problem "A Study of Schemes of Logical Thought Among Certain Groups of Ugandan Adolescent Pupils With Special Reference to Quantitative Knowledge". This thesis is a record of bonafide research carried out by him for the award of Ph.D. degree, supervised by me. No part of the work has been submitted for any degree elsewhere.

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E. Kyangua

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ABSTRACT OF THE THESIS

The study processed cross-sectional data, for the validation of Piagetian presuppositions on aspects of schemes of logical thought observed through performance scores, on Piaget-type tasks. Six hundred, and sixteen (616), Ugandan adolescent pupils, (randomly selected from 10 Ugandan Upper Primary, and Lower Senior Secondary Schools), formed the subjects; of which, two hundred and seventy (270), were sampled for study, (selected on the basis of original scores of sex, age, and grade on Numerical Ability Test, matched with the respective normed scores of LAT Sub-test of Numerical Ability). Twelve Piaget-type problems were developed to study twelve proposed schemes of adolescent thought. A study of reliability and validity coefficients of the problems was also made. Results of the review of related literature revealed evidence of the proposed schemes as being achievable by subjects aged, between 12 and 15 years, described as concrete as well as formal operational thinkers. They were grouped into three, namely as : Younger subjects (aged from 13 to 14 years), Middle Age Subjects (aged from 14 to 15 years), and Older Subjects (aged from 15 to 16 or more years).

The study attempted to validate and extend some recent research findings on Piagetian conceptions,

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regarding (1) adolescents' schemes of thought, (2) adolescents' logical abilities; and (3) adolescents' scientific thought. Four outside variables, of psychological tests of : Intelligence, Numerical Ability, Abstract Reasoning, and Verbal Reasoning, were also administered. One way analysis of variance technique, (of the 't'-test), was used to determine age, sex, and grade performance differences. A computation of inter-correlation Matrix coefficients, of performance scores were made, and further subjected, to Factorial Analysis by Principal Method, with Varimax Rotation, for the study of factorial structure, of adolescent thought.

The main findings of the study indicated that : (1) Younger subjects performed better, on tasks involving symbols, matrices, patterns, manipulations with Concrete objects, and verbal reasoning; (2) Higher grades of the subjects topped, in the four psychological tests; (3) Performance scores on intelligence, and numerical abilities, increased with age, and grade; (4) Older age subjects as well as, male subjects topped, in the majority (nine), of the twelve schemes of thought problems; (5) Older subjects, as well as, subjects of unemployed parents topped, in schemes of thought involving, logico-mathematical thought, and inductive reasoning; (6) No significant differences existed between low and high

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scores of, total performance on the twelve schemes of thought; (7) The subjects exhibited logical, as well as, scientific thought on, the majority (75%) of validated schemes of thought.

The results accordingly confirmed the central ideas in the Piagetian theory : that children at first lack, the capacity, either to understand their environment, or to reason about it coherently, but gradually acquire the abilities through informal experiences, in the course of time. Evidence to the effect was shown by increased age and grade obtaining, more higher performance scores, and significantly large numbers, of formal operational thinkers being found, in the groups of older age subjects. The Piagetian pre-suppositions, concerned with the kind of experiences, leading to children's intellectual growth were shown to include : mental exercises with tasks involving, manipulations with concrete objects; abstraction of concepts; hypothesing; experimentation and drawing logical conclusions. Educational implications, as well as, suggestions for future study have been outlined.

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CHAPTER I

INTRODUCTION

Piagetian Conception of Knowledge

In regard to human knowledge there are two questions that may be asked: first, what do we know? and second, how do we know it?.... (Bertrand Russell: Human knowledge, its scope and limits). In the language of logic, knowledge either describes a thing or it operates, on a thing. Professor Jean Piaget believed that, all knowledge is transformation of reality. One is said to have known something if, and only, if, one knew how to construct or transform it. The growth of knowledge in the child, Piaget maintained is, due to the emergence of a sudden insight, independent of preliminary preparation; and viewed the development of knowledge as the result of a process of elaboration that is based, essentially on the activity of the child, which activity is, distinguished in two ways. First, a logico-mathematical, which brings together or dissassociates orders of counting and so on, in which the objects are no more than a support; and second, a physical activity of exploration, aimed at extracting information from objects.

Philosophically, Piaget chooses as his point of departure, categories of experience and reasoning that occur in classical logic, starting from Aristotle to Kant and conceived of the laws of thought as developing in each child's mind. He and his co-workers of the Geneva School of Genetic Epistemology hold, the view that knowledge is not acquired, say through direct observations, but through the actions carried out upon perceptions, not so much of the actions of the body but, of mind and mental operations. Piaget's life long strategy has been to transform seemingly unmanageable metaphysical questions like: what is reality? What exists? and others, into manageable epistemological questions, such as: How do we know ? How do we get to knowledge and similar others. To him, when the individual and the social group engage in activities, they are constantly, in the process of constructing and reconstructing their views of the world. Thus, they are in pursuit of knowledge, and become aware of the world around them. Such type of knowledge he maintained is, momentary and plays, a regulatory role with regard to other latent achievements. It may be complex or of simple kinds, but it is not necessarily of ultimate reality. Such assumptions, and techniques of their implementation gave rise, to Piaget's life-long works, referred to as genetic epistemology. Figure 1.1 shows placement of the Piagetian conception of knowledge with reference to other fields of knowledge.

Figure 1.1

Showing Placement of Piagetian Conception of Knowledge

- THE ENTIRE FIELD OF KNOWLEDGE
  - Philosophy
    - Other Philosophies
      - Other Epistemologies
      - The Epistemology of Piaget(*) or Genetic Epistemology
    - Epistemology
  - Other Fields of Knowledge

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* Indicates the Piagetian conception of knowledge grounded on, Organismic Development Paradigm, (Ashenbach, 1978).

<u>Operative and Figurative Aspects of Piagetian Knowledge</u>

Piaget (1971 & 1975) defined the relationship and functional continuity that connect the process of the formation and development of knowledge to the biological mechanisms of auto-regulation, peculiar to the organism, thereby stressing the operative-figurative distinction of knowledge. He introduced comparable biological* terminologies to describe, the types of processes, taking place in the knowledge formation. In biological context, the term exogenous implies a variation imposed by the environment and is thus phenotypical, but not hereditary. Endogenous implies information drawn, from the internal and necessary coordinations of actions, and is thus the product of interior structurations. Piagetian exogenous knowledge originates in the observable, is based on experience with external objects, grows with material aspects, and results from the actions of the subject. Hence, its process is operative, and, the aspect of knowledge is, inferential. Examples are: to establish that one object is heavier than another, and to confirm if one action is of longer duration than another.

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* Some of the key terminologies are the following :

Exogenous-meaning, a growing from or on the outside of organism. Endogenous-meaning, a growing or organization within the organism. Phenocopy-meaning, a growing which is caused by an unusual environmental condition and which resembles the normal expression of a genotype, other than its own. Genotype-meaning, the genetic constitution of an individual or group or a class of individuals that share specified genetic make up, (Piaget, 1971).

Endogenous knowledge is derived from the internal coordination of the actions or operations of the subject. For example, in transitivity, we have A is less than C, if A is less than B, and B is less than C. In such a case, the process is descriptive imaginative and of perception. Such aspect of knowledge is called figurative. The operative aspect of knowledge assumes that one knows the object by acting upon it in order to transform it, and one discovers its properties through transformations. In the figurative aspect, knowledge is copied (Geber, 1977), as well as observed.

In the experiment of simultaneous placing of red and blue beads into two separate containers, Piaget and his co-workers (1971) sought to investigate the subjects' reactions with reference to equility of collections and the retention of equility concept in the event of an indefinite continuation of collections of the two-colour beads. The aim was to confirm whether, if the subject perceived the results of his actions, does he accept the equality principles as being self-evident, and if so, does he refute the prediction in principle, of the result of continuing the process as certain? The experiment showed testing of figurative aspect of knowledge symbolised in the equation: if $n = n$, then follows the identity $n+1 = n+1$. The results of the experiment convinced Piaget to conclude that the subjects no longer reasoned from the results of the observed or interiorised actions, but on necessary coordinations

resulting from certain generalizations. Piaget (et al) thus tested the general process of the replacement of exogenous knowledge by endogenous reconstructions, showing that, all figurative knowledge has, some operative components of these actions.

In another experiment of a series of moving marbles: ABCDE (of Inhelder, 1959), a moving marble F, that rolled down a slope, was made to hit the series at A. It was observed that marbles from A to D remained in their places, but marble E was linearly propelled forward. Subjects aged, from 5 to 6 years explained the phenomena as a displacement, that starts from A, the point of knock, continuing through B, C and D, till the point E of propulsion. When asked to explain, they asserted that they actually saw the transmission. But subjects aged, from 7 to 8 years explained the phenomena by a new notion - a push, that traversed the intervening balls. For them, the passage across was no longer the observable but a product of deduction. An inference arose from the reasoning, as a result of transitivity: A = C if A = B and B = C. Subjects interpreted the results of their operations on the objects, through models of endogenous operations. The deductive aspect of the experiment consists, in the imagination of operatory structures to objects, and external events, that are mathematical, and implying endogenous elaborations. The experiment showed, the inferential nature of operative knowledge and thereby confirming the different perspectives of figurative and operative knowledge to be of the same whole.

Piagetian Stage Development

Jean Piaget's epistemological interests in children started as early as 1919, when he was 23 years old. He came to Paris to carry out the studies and practicum, in the laboratory left empty by Binet and Simon (Murchison, 1952). It was there that the young Piaget spent his mornings at the celebrated National Library of Paris, reading works of logic by Couturat and Coblot and, it was there too, that Piaget began his theory of stage development by devoting his time to, carrying out Theodore Simon's suggestion that, he standardised the French version of certain tests of reasoning by Cyril Burt (*). Instead of administering the tests in a standardised form, Piaget chose to interview the children at length and instead of noting the responses received from the children, Piaget interested himself more, in obtaining answers to the how and why questions. What had been previously a boring and annoying test situation turned out to be a real dialogue with suggestions and counter-suggestions, (Murchison, op. cit.). Thus, Piaget had developed his technique, adopted in his future researches, of employing arguments in testing; and of analysis, of answers and responses, the results of which led him to conceive of a theory for grouping children's thinking into stages of development.

Piaget's original stages consisted of three response patterns. Firstly of those children who could not answer

(*) The work left behind unfinished by the death of Alfred Binet and the departure to Rouen, of Theodore Simon (Murchison, 1952).

questions put to them because they could not understand the nature of the testing itself or the principles involved in the tasks and questions; or of those who tried to answer the questions but showed, by their conclusions that they are not thinking along the same lines as adults. In both cases, their thinking were termed to be in pre-operational stage of development. Secondly of those children who were groping towards the right solution. Their answers were sometimes correct and sometimes incorrect. They were grouped as of transitional stage of development. Thirdly of those children who showed correct responses and justified their answers with explanations. Their answers showed that the children had attained a steady understanding of the concepts involved. Their thinking was grouped as of those children in the operational stage of development. Later, dissatisfied with these classifications and other previous efforts. Piaget revised and reworked the whole of the classifications and his other past works*.

In its strict sense, stage development refers to cognitive ability and levels at which an individual comes to be able to think and learn to perform certain actions, as he

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* Piaget's habit was to write down almost everything he thought of and publish almost everything he wrote. He regularily contributed to both local and foreign journals, newspapers students' forums and other international publications. To date, his works are quite colossal and the publications, astonishingly large (Gruber, 1977).

grows older. Freud (1900, 1915) theorized on instinctual or drive stages of a person in a normal and pathological behaviour grouped into libido, ego and super ego stages. Erikson (1950, 1959 and 1963) theorized on stages of : basic trust of the child; the child's sense of industry; adolescents striving for, mature status, and self identity, and physical rebellion. According to Piaget (1927, 1935, 1950, 1966) stages of development in the individual encompasses, groupings schemes or classifications, of the individual's thinking abilities and operational levels, represented in response patterns, His initial levels of schemes, were of: autistic stage of (0-1/2 years) infant, representing the first phase of mental life through which the infant passes; egocentric stage, of a child (of 1/2 - 7 or 8 years) which represents, the stage after autistic phase and lastly, social stage, of a child (of 7 or 8-16 years) which represents, the stage when the child's real social behaviour begins, and in which child has mutual understanding in his conversation and commences the art of criticism of others and of himself. The child makes an attempt at reflective thought, logical unification, and avoids contradiction at this last stage.

Piaget's most formalized and widely accepted* theories, regarded as new areas of research consist, of four

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* A summary of Research in Science Education, (1972 p.20).

stages. These are: Firstly of sensory-motor stage, which occupies approximately the first eighteen or twenty four months. It is characterised by the progressive formation of the scheme of the permanent object by the individual and by the sensory-motor structuration of the individual's immediate spatial surroundings, originating in the functional exercises of mechanisms that are reflective in origin and leading gradually to a system of movements and displacements. The individual differentiates its own age at a later stage of the period, when it situates its body in spatially and causally organised fields, composed of permanent objects and persons. Similar to itself. Secondly of pre-operational or pre-logical stage, which extends from the beginning of the second year until the seventh year. It is characterised by a long process of elaboration of mental operations by the individual, who shows a simple memory for past experiences, desires for distort and reasons from particular to particular at the cost of underlying unity. Acquisition of symbolic functions are, actively experienced. The individual considers thing in his own frame of reference and attempts to use abbriviated visual image, symbols, and motor sequences for activities and events. Thirdly of concrete operational stage which extends from the age of about seven years and ending by the age of eleven. The individual has a mobile state of balance marked by a state of reversibility, coordinated transformations, and processes of structuration. Concrete thought processes are irreversible during their

elaboration. The individual does not accept hypothetical data and cannot react to abstract situations. The genesis of his thought processes ensues in the form of elementary logico-mathematical thought structures, and he is able to structure, objectively, relationships between classes, relations and numbers. Fourthly of formal operational stage, which begins, on the average, at about eleven years of age, and continues upto the age of sixteen. It is characterised by the development of formal abstract thought processes of the individual. In a rich cultural environment, the processes are found to have come to form a stable system of thought structures, at about fourteen or fifteen years of age. The individual is characteristically, capable of forming hypotheses and deducing possible consequences from them. The hypothetico-deductive level of the individual's thought expresses itself in linguistic formulations, containing proportions and logical constructions, implications, disjunctions and so forth. It also shows itself in the manner in which, experiments are carried out and proofs are provided.

Each of the Piagetian stages involves a period of formation, called genesis and a period of attainment defined by the progressive organisation of a composite structure of mental operations. Each structure constitutes simultaneously, an attainment of the one stage and the starting point of the next stage, seen as a new evolutionary process. The order of succession of the stages is constant and ages of attainment very within certain limits as a function of factors of

motivation, exercise, cultural millieu, and so on. The transition from an earlier to a later stage follows a law of implication analogous to the process of integration, preceding structures and becoming a part of later structure. The validities of these distinguishing characteristics are of immense research interests and have been checked and confirmed experimentally by Piaget, Inhelder and others. The stages are found to develop or result from the interplay of three factors, namely: Maturation; Experience with the physical environment; Experience with the social environment; and Equilibration. Piaget and Inhelder (1959) performed several experiments associated with this stage. Table 1.1 shows a few of the key schemata experimented.

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Table 1.1

Showing some original Piagetian* Experiments

E. No.	Schema	Experiment
1.	Combinations	Chemical combinations, in a system containing a substance to be coloured, a dye, an inhibitor and a neutral agent.
2.	Proportionality	Equilibrium on a balance beam, where the multiplicative relation between length and weight, must be dealt with.
3.	Correlations and probability	Discovering the relations between a pair of imperfectly correlated variables (Hair and eye colour).
4.	Inversion and reciprocity co-ordinated in maintenance of equilibrium	Behaviour of liquid in communicating vessels (equality of water levels, relation between water pushed out of one tube and into the other.
5.	Mechanical equilibrium	Hydraulic press (a more quantitative version of the preceding).
6.	Coordination of two reference systems	Snail moving on a moving platform.
7.	Equilibrium of work, mechanical proportions	Behaviour of wagon on variably inclined plane counter-balanced by variable weight on pully (system).
8.	Geometrical proportionality	Predicting size of shadow cast with objects varying in size and distance, screen and source varying in distance.
9.	Compensation of interacting variables	Behaviour of balls on rotating platform relation between weight and distance from centre in determining centrifugal motion.

*Essential Piaget (1977).

Need and Justification of the Study

Piaget (1896-1980) has so elaborately presented ways and means of studying and understanding children's epistemological ideas and logical thoughts. He spent the whole of his life time, conceptualising and studying children's interactions of external events on their internal structures, describing them to take place at marked intervals and with characteristic patterns. He has written and published volumes of books thus making it possible to study and substantiate his presuppositions and theories. Unfortunately, not much research attention was focussed on the works. It is only recently that a great deal of research interest began to show, with emphasis to replicate, extend or validate some or all of his works.

The educationist wants to know how and when pupils can, effectively acquire knowledge. The psychologist needs to understand the operation of knowing and of the growth of human knowledge. The educationist, as well as, the psychologist is interested in the study that leads him to understand and evaluate how knowledge is constructed, and the form in which it is substantiated. These are only a few of some of the felt concerns Piaget-inspired researches pose.

Need for replication and extension of Piagetian Studies

Piaget makes a distinction between two types of knowledge - operative and figurative. The operative aspect of knowledge refers to those activities that attempt to

transfer reality, as it appears. Operative type of knowledge embodies what Piaget calls knowledge-as-assimilation; and, the figurative aspect is the knowledge-as-copy. Both aspects share the hypothesis that the object exists. Their difference may only be with regard to the acquisition of knowledge of the particular objects. By the knowledge-as-copy, perception of and images induced by the object are sufficient to provide knowledge. The epistemological problem remains, that of matching the phenomenon and its image. Its cognition is not based on the subject and the object alone but results, from action and reaction of the two. It refers to two types of acquisition, one relating to the inter connections between properties of the object, the other to the coordination of the actions themselves, which need to be structured. Thus, there is the theory of knowledge which emphasizes the active construction of knowledge as well as, interactions of the subject and object, for which further research studies are recommended.

According to Piaget, a normal human being undergoes, at least four, major stages of cognitive development, from the moment of birth to the period of adolescence, which are: The sensory-motor stage, manifested during the age range of (0-2) years is, the stage when the individual's behaviour in interaction changes, from the first reflex-like forms to motor habits. The preoperational or pre-logical stage, manifested during the age range of (2-7) years is the stage when the individual's acquisition of symbolic functions are

actively experienced in the periods of interaction. Concrete operational stage, manifested during the age range of (7-11) years is, the stage when the individual has a mobile state of balance in the event of interaction. And the formal operational stage, manifested during the age range of (11-16) years is, the stage when the individual maintains independence and acquires capacity to draw purely formal conclusions from hypothetical assumptions in the events of interaction. Chronological ages shown are only approximate ranges. Hypothetically, some children reach a given stage earlier or later than those shown, and children in millieux, other than the United States, Britain and other industrially developed countries may take a longer or shorter time to reach a given stage. By formulating these stages, Piaget is understood to have defined knowledge as a process that develops; is dynamic and is influenced, both, by the social environment and the process of maturation (Geber, 1977). Understanding of what occurs at one stage in time is enhanced by what came before and what follows. Indeed it is conceivable that only by putting a behaviour into a time context can it be fully understood. The implications of all this, for research in psychology and education show, our indebtedness to Piaget. Piaget is certainly not unique in calling for studies of change over the individual's life span, nor even in suggesting that a developmental perspective is essential for understanding intelligence and epistemology. He makes his particular contribution in the range of problems

and the variety of areas to which his articulated theory can further be studied and applied, thus giving rise to the emergence of the current study.

Piaget (1961, 1966 and 1968) has interested himself in issues concerning intelligence and cognitive developments in the individual, as well as working out, formalised explicit theories in perceptual patterns of development. He published (in 1961, 1966 and 1968) impressive and even longer series of studies on a variety of perceptual phenomena as well as, on figurative aspects of knowledge. Perceptual development in his view is an essential forerunner of cognitive development; for what is seen or heard will determine how one reacts, and conversally, what is seen or heard will depend on what one already knows. This aspect of, figurative knowledge too calls for further investigation.

Piaget's philosophy pervades all his work, be it work labelled; psychology, logic, biology, education; or contributions, in journals and prefaces, to other author's books. His approach to philosophical problems is peculiar. Unlike most scientists who generate problems from questions internal to their field or research. He generated problems out of general philosophical questions. Among his multiple contributions to knowledge, the one that placed him high in the epistemological spectrum has been of genetic epistemology. He has touched on almost every branch of philosophy, with the exception of probably aesthetics. He touched on ethics, logic, social philosophy, and ontology, (just to mention a

few). He believes in constructivism, as the only possible epistemology. He distinguished three periods in the history of epistemologies. These are of: metascientific epistemologies; para-scientific epistemologies; and scientific epistemologies. He referred to meta-scientific epistemologies as belonging to those philosophers who were at the same time scientists or who used the contemporary Science and gave Hume's empirism and Kant's a priorism as key examples of metascientific. Para Scientific epistemologies developed in the 19th century when many philosophers adopted different attitudes towards science, in search for other super-scientific forms of knowledge. Bergson was one of the representatives of this category. Other para-scientists, like Husserl resisted, against scientific metaphysics. Scientific epistemologies have only recently been developed. The exponents restrict themselves to problems concerning scientific knowledge. Many of them (Russell, Wittgenstein, Whitehead) were specialised scientists mathematicians, physists, etc. with interest too in epistemological problems.

In reviewing the above philosophical issues, Piaget believed that despite the tendency of scientific epistemologists to delimit the problems studied, there is no difference in nature, between philosophical and scientific cognitive problems, and that their fundamental difference is to be found in the methods used. He suggested areas and problems, as well as, methodologies of research involving

philosophy and science. These deserve further clarification and follow-up.

Piaget's approach in the study of knowledge differs from the classical ones of child psychology. They differ from the associanist of Gestalt inspired investigations, where the child is presented with elements or configurations. His method, known as "clinical method" lays bare the operational mechanisms of the subject's thought. The subject is brought to grips with physical or spatial transformations of the object. The experimenter does not only take note of the responses received but asks questions in which the subject's explanations are recorded. Standardization and further analysis come after exploration of the whole range of the subjects' reasoning. His analysis included: a quantifying classification of the different types of reasoning; obtaining of an analysis, in terms of logical models; effecting an analysis of frequencies of responses and dispersions by ages; and obtaining a hierarchical analysis by means of ordinal scales. There is, therefore, the need to study and to compare results of investigations obtained, using the Piagetian data analysis with a repetition or use of, any others.

We are indebted to Piaget in bringing to our attention the potential for realting a number of separate educational and psychological processes and domains of content directly, as well as through a developmental perspective. Cognition;

discovering the stage involved in getting to know the world in which we live, and understanding ourselves as well; examining the historical philosophical and the life-space context, of change and of growth are, some of the benefits Piaget's works have brought. But theories adjust to information and to criticism in a manner analogous to that of the accommodation of schema.

Accordingly, Piaget's theories like all scientific theories are, regarded provisional and tentative and, therefore, subject to further testing and verifications. It is in this amenability to testing, to change, or to falsification, that the current study draws on its need and justification for a research study in Piagetian genetic epistemology.

Statement of the research problem

Studies in genetic epistemology are characteristically context-free, content-free, developmentally based on mechanisms and structural models of each of the Piagetian stages of development. They concentrate efforts in the question of knowing and the development of knowledge, and establish relationships of each of the studies to Piaget's theories (Sigel, 1968) and Geber, 1977). Research in Education series (1972 and 1976) strongly endorse the Piagetian studies and focus attention on the intellectual models of Piaget, recognising them, researchable. Never-the-less, it occurs to the researcher that relatively little is

done and known about the Piagetian works especially in Africa and not much attention has, so far been paid to cross-cultural researches on adolescents, in the developing countries. Hence the emergence of the present study. The research conceived was centered around the theme :

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CHAPTER II

REVIEW OF LITERATURE, AND FORMULATION OF HYPOTHESES

CHAPTER II

REVIEW OF LITERATURE AND FORMULATION OF HYPOTHESES

Some Related Studies

Piaget has opened up new avenues of research problems in such areas as: genetic epistemology, Science Education, and developmental psychology. The emergence of the Piaget-inspired researches are, of recent origin. In the early 1900's, the prevailing view of psychology, in education, was of regarding school-aged children imitating, both thinking and emotion of the world to which they were exposed (Kagan, 1980). There arose, therefore, the need to switch to a new out-look of regarding the School-aged children viewing the world of objects and people, as something playing essential roles for their inherited insight; and, as real forces in their thinking and intellectual development. Piaget inspired researches afforded the possibilities, in that direction. The researches go as far as: to design investigations that have cognitive, as well as developmental orientations and to assess human activities, that are of interactionist nature.

By the early 1920's behaviour was the major influence in child development researches. This was particularly evident when, G.S. Hall, J.M. Baldwin, William McDougall, E. Claparede, Wilhelm Stern, Kurt Koffka, and J.B. Watson all made, major attempts to encompass the facts of child behaviour and development into their general psychological theories (Mussen, 1960). Learning then was described as behaviour that was acquired through explicit reinforcements rather than as internally inherited instinctual constructs with external phenomena. A major shift of interest and an advance in the quality of empirical data in developmental psychology and child development research began, with the work of Binet (1903 & 1905) based on mental testing. The mental testing movement, from which stemmed Piaget's interests in child studies for a time comprised, almost the entire field of developmental psychology. Although they do not describe all aspects of development or any single one for that matter, mental tests do provide performance scores that are designed to show a continual gradual growth with age.

The decade 1920-1930 marked the initiation of a number of longitudinal growth studies conducted in America, Britain and other countries (with major research interests). These long range longitudinal researches were not all alike by any means, but, as originally conceived, were proposed to chart the physical, physiological and psychological growth

of individual children over a period of years (Achenbach, 1978). The entire atmosphere of child development research shifted in or between 1935 and 1945. It turned to studies of effects of weaning, toilet training, birth inquiries, broken homes etc., upon psychological development of the child. They included researches conducted in the Freudian "by stage" theories of, psychoanalysis, of child experiments which Erikson (1959 & 1963) extended to include studies on children's changing profile of psychological conflicts. Progress in studies of developmental psychology continued in the direction of mental assessment in the 1960's and 1970's. Bruner proposed a theory of cognitive growth in the 1960's. He believed that, the development of human intellectual functions, from infancy to the adult's peak, in performance is shaped, by a series of technological advances in the use of the mind. He also took-up the issue of language in cognitive development studies. Piaget's researches widened the scope of developmental, as well as, mental assessment studies, which focused on epistemological problems in children. According to Piaget (1968), a genetic study of the construction of concepts and operation provides, responses to questions posed by science (op.cit.) with respect to methods of knowledge, and describes how, in the process, child psychology becomes extended, to studies in genetic epistemology. To-date, such studies are deemed a Piagetian research study if they satisfy one of the following criteria: They are Piaget-oriented (replication or

extension); and, they are developmental in nature; or they are designed to discuss their findings within the Piagetian frame work, (Modgil and Sohan, 1976).

Key Researches' Based abroad and in India

Of all the Piagetian operational stages, formal operational stage has received relatively little empirical attention. Inhelder and Piaget (1958) stated that formal thinking develops between the ages of 11 to 15 years with an equilibrium point being attained at age 15 years. Central empirical questions asked, in the Piagetian researches then, concern themselves with: (1) percentage of adolescents, exhibiting formal thinking at the age of 15 years, or at other ages before and during adolescence; (2) growth of subjects' ability to solve a set of physical problems, each of which drawing attention to a particular schema; (3) growth of ability of subjects to execute, or to formulate and test hypothesis; and (4) extent of the subjects' developmental, cognitive tangibility (epistemological hierarchy). Experiments are designed to analyse, subjects' observed situational interactions with regard to mental or intellectual operations.

Research in Piagetian formal operational stage has been attempted by researchers based, both abroad, as well as in India. Of the related research studies reviewed, the following few have a direct bearing on the present study. Starting with studies conducted abroad they include

studies of Dale (1970), Jackson (1965), Lovell (1961), Lunzer and Parfrey (1966), McNally (1970, 1971) and Tisher (1962; 1971), who reported 50 percent or less of subjects, manifesting formal thinking at the age of 15 years. Lunzer and Pumfrey (op.cit.) focus on the lack of ability of less than five percent of 15 year old children of average intelligence, successful in the balance situation, to explain principle of balance. Lovell (op.cit.) and Jackson (op.cit.) suggested that only bright pupils could interpret problem situations even at the age of 15 years. With respect to younger children, Tomlinson - Keasey (1972) Identified 32 percent of 11 year old female subjects operating at the formal level. Of the 50 eight to ten year olds, with I.Q.'s 140+. In Lovell and Shields (1967) study, only ten percent functioned at the level of formal thought. Yudin (1966) and Kates and Yudin (1964) identified significant gains in the utilisation of hypothesis testing of subjects from 12 to 14 years of age. In the study of Dulit (1972), no subject in the youngest 14 year old average group functioned at the fully formal level on both tasks, and only two out of the 21 subjects functioned in one task. Ross (1973) was in agreement with Tomlinson Keasey's (op.cit.) findings that a college educated sample has significantly more than 50 percent of the subjects functioning at the formal level, however percentages were less at the most developed stage for formal thinking. The studies cited,

therefore, suggest that formal operations can be attained at very different ages and levels of educational instruction. None of them detracted from the essential validity limitations of Piaget's generalizations on schemes of adolescent logical thinking and formal operations.

In India, Piaget-inspired studies have been vigorously pursued for well over one, or so, decades now. More noticeable are the studies on Adolescent Thought conducted in Science Education, Supervised by Prof. N. Vaidya*, published under the auspices of the Extension Services Deptt. of Regional College of Education, Ajmer. Included in the review are those having relevance to the present study. They are: Vaidya (1975), which found mean scores on various schemes of adolescent thought increased with grade; Sandhu (1980) which found significant correlations existed between intelligence and adolescent logical thought, Jain (1981) which found problem solving ability differed significantly among pupils operating at three intellectual levels; Padmini (1981) which found Majority of successful problem solvers were 14 year olds and unsuccessful problem solvers were 10 year olds; and

* Professor N. Vaidya has conducted, written and published several monographs, and books on schemes of adolescent thought, in Science Education Studies. (Vaidya, 1979).

Jacob (1980) which found mean performance scores on conservation, proportionality, classification, force and pressure showed, increasing trend with grade.

Tentative aspects of logical thought were shown which existed factorially, in Vaidya & Padmini (1980) list of factorial structure of adolescent thought. The list recorded schemes of logical thought studies of scholars and researchers based both abroad and in India. The findings with relevance to the present study included the following factors : (1) Generalised intellectual factors (Matab, 1964), Beard (1957), Peel (1955), Vernon (1971), and Sandhu (1981). (2) Exclusion of variables factors (Shayer, 1968); (3) Seeing the problem as a whole factor (Vaidya & Misra, 1975); (4) Formulating Hypotheses factor (Vaidya, 1975); (5) Using constant Difference factor (Vaidya & Manju, 1984); (6) Combinatorial grouping factor (Vaidya, 1975); (7) Symbolisation factor (Vaidya, 1975) and (8) Stating and Testing Hypotheses factor (Sandhu, 1980).

Most of the Indian based studies, like other studies conducted abroad have found that, (1) Piagetian tasks (problems), measure Piagetian formal thought; (2) formal thought is necessary for proportional reasoning (thinking); (3) structure of formal thought is bifactorial, namely : verbal and non-verbal; (4) adolescent thought shows a form and context of grouping; of concrete operational and

coordinating concrete-logical; and (5) Piagetian tasks administered to a group of subjects does not give the same factorial structure, sexwise, as does when administered, individually (Vaidya & Manju, 1984).

Piagetian Studies at a glance

Original Piagetian studies and Piaget-oriented studies have become so numerous that a review of them, be it at concrete or formal operational stages, can best be wholly or partially covered if studied in outlines. The following tabular presentation (of table 2.1) is an attempt to outline the main related Piagetian studies conducted, abroad, and in India.

Table 2.1

Showing Related Studies at a Glance

S.No.	Name(s) of the author(s) and year of publication	Title or Problem(s) of the study	Main findings of the study
1	2	3	4
1.	Heidbreder(1928)	Problem Solving in Children and Adults	Reactings and sensitivity to problems increased from subjective attitude to a more objective attitude. A general pattern of new rigidity to problem solving was met with increasing age levels.
2.	Kyle (1950)	Thought Processes	(i) Able pupils did not solve problem in stages. They jumped from stage to stage. (ii) A problem became real only after some rudimentary fore-sight of tentative solution. (iii) A 'doing group' went further towards a solution than a thinking group.
3.	Cohen & Hansel (1955)	Independence	Most of the mid adolescent pupils (under 75%) failed to develop the concept of independence.
4.	Buswell (1956)	Patterns of thinking in problem solving	(i) Subjects experienced difficulty in expressing concepts verbally which they had in fact acquired. (ii) They did not estimate answers before they started solving problems. (iii) Their failure to distinguish between relevant and irrelevant aspects of the problem attracted all

1	2	3	4
			sorts of responses. Variety rather than similarity in the sequence of thinking was the most striking and outstanding characteristics even when common and uniform patterns of thinking were seen during the entire act of problem solving.
5.	Inhelder B. and Piaget, J. (1959)	Growth of Logical Thinking: From childhood to Adolescence	(i) Concrete operational subjects could describe results of their experiments but failed to hold other factors constant. (ii) Formal operational thinkers attempted to prove activities through control experiments.
6.	Wheeler (1958)	Development of Reasoning	Contradicted Piaget. He found that elementary schemata were very much there even among young children. It was their subsequent development which described difference in performance.
7.	Peel, E.A. (1960)	The Pupil's Thinking	Confirmed Piaget in Principle. He identified four kinds of thinking, namely: the metric; explanatory, productive and integrative.
8.	Lovell, K. (1961)	Growth of Logical Thinking	Confirmed Piaget in Principle and found that pupils of low academic ability failed to develop formal operations even past their mid-adolescence.
9.	Mealings (1961)		(i) Problem solving in science was more related to intelligence than to chronological age. (ii) There appeared a minimum mental age of 13 years before a child could reason formally about a problem. (iii) There was a time lag between empirical solution and formal solution.

1	2	3	4
10.	Smoke (Ed.Harris & Shelvain) (1961)	Learning Processes	(i) There was a form of grouping in concept formation. (ii) In firm, concept formation was achieved but hypotheses were set up and tested for their validity. (iii) Insightful behaviour was present in some situations. (iv) Subjects had difficulty in expressing their concept verbally which in fact they had acquired.
11.	Beard,R.M.(1962)	Children's Reasoning	There were vast individual difference in levels of thinking among adolescent pupils studying in different schools. Previous classroom experiences appeared to play an important factor in separation of variables.
12.	Bruner,J.S.(1962) Goodnow, J.J. & Austin G.A.	Thinking : Styles of Formation of the thinking concept	Four distinct strategies were distinguished by which a person formed given concept : simultaneous scanning; successive scanning; conservative focusing; focus gambling.
13.	Case, R.D. and Collinson J.M. (1962)	Development of Formal Thinking	Scores on formal thought tasks varied even when subjects were matched on CA and MA, who were drawn from different cultural backgrounds.
14.	Vaidya,N.(1964)	Problem Solving in Science	(i) Adolescent pupils were in a position to stage hypotheses but most could not test them. (ii) They did not, contrary to Piaget, exhaust all possibilities. (iii) A given problem was solved over a wide I.Q. range, only within a given age and across various age groups.

1	2	3	4
15.	Jackson, S. (1965)	Growth of Logical Thinking	About half of 15- year-olds attained formal operational stage.
16.	Lovell, K. and Butterworth J.B. (1966)	Abilities	Majority of the adolescent pupils did not reach the formal operational stage.
17.	Yudin, L.W. (1966)	Formal Thought in adolescence and growth of logical thought	Adolescent pupils of average intelligence, contrary to Piaget, showed concrete thinking behaviour. Added age was an important factor in the development of formal thought.
18.	Gunnels, F.G. (1967)	Development in Logical Judgements	(i) Age was an important factor in the development of formal thought. (ii) Stage concept in thought developes, sequentially was, confirmed.
19.	Dale, L.G. (1970)	Growth of Systematic Thinking	Very few adolescents performed at the formal operational level.
20.	Bart, W.M. (1971)	Factor structure of Formal Operations	In addition to the large general factors, formal thought did comprise verbal as well as non-verbal thought.
21.	Higgins-Trenk, A. & Gaite A.J. (1971)	Exclusiveness of Formal Operations	American adolescent pupils attained formal thought only at the age of nineteen or so.
22.	Kohlberg and Gilligan, C. (1971)	Discovery of Self	All normal children attained concrete operational level but few formal operational.
23.	Macks, S. and Macks, V. (1971)	Development of formal Thought	All fifteen year old adolescent pupils manifested formal thought who systematically approached the simple pendulum problem.

1	2	3	4
24.	Dulit (1972)	Formal stage	Two fifths of the gifted pupils (16-17) year olds failed to attain formal thought as tested through several Piaget type problem. Among the general population (of 20-55 years) about two thirds failed, to achieve formal thought.
25.	Lengel, R.A. and Buell, R.R. (1972)	Exclusion of Irrelevant Factors i.e. The Pendulum Problem	(i) In between grades 7 and 12, there was gradual growth in logical operations of exclusion. (ii) Measures of I.Q. and socio-economic status had little relation to conservation.
26.	Lewis, W.R. (1972)	Influence of Sex age	Formal thinking was highly dependent on age rather than any other variable.
27.	Lunzer, E.A. Harrison, C. and Davey, M. (1972)	Card Problem (i.e. Probability Problem)	Formal operations was quite low in the general population.
28.	Wells, J. (1972)	Aspects of Adolescent Thinking in Science	Mental age rather than chronological was determined quality of thinking. A wide spread of mean was noticed, however, for both C.A. and M.A. when, thinking was classified in various ways: Describer level, Extended describer level, Explainer, Using analogy and Using inference etc.
29.	Misra, H.M. (1973)	Role of hypotheses in Problem solving	There was no significant difference between top group and bottom group on a number of hypotheses; (ii) A given problem was solved over a wide I.Q. range i.e. a low I.Q. pupil failed to do better; (iii) Many adolescent pupils experienced difficulty in testing hypotheses.

1	2	3	4
30.	Saarni, C.I. (1973)	Problem solving performance	Piagetian development level did predict problem solving performance.
31.	Weeks, R.T. (1973)	Relationship of grade, sex, socio-economic status, etc.	Ninth graders failed to show formal thinking.
32.	Blasi, A. and Hoeffel, E.C. (1973)	Adolescence and Formal thought	Logical basis for conceptual thought disappeared when meanings varied on possibility and were reflectively analyzed.
33.	Case R. (1974)	Learning and Intellectual Development	Subjects aged (7-8) years who were intelligent and field independent acquired, control of variables in the absence of conservations of weight or combinatorial grouping.
34.	Docherty E.M. (1974)	Identifying Concrete & Formal Operational	With the help of the Pagetian tasks, it was possible to identify concrete and formal stages using cluster analysis.
35.	Graybill, L.A. (1974)	Sex differences	Sex differences for boys in logical thinking were noticed.
36.	Kidder, F.R. (1974)	Comprehension of Euclidean Transformations	Failure to conserve length attracted errors on problems involving Euclidean Transformations.
37.	Lawson, A.E. (1974)	Relationship of concrete and formal operational	Percentages of students studying chemistry, physics and biology manifesting formal thought were 64, 63 and 35, respectively.
38.	Lawson and Renner (1974)	Relationships of Science subject matter and	About 22 percent of the college freshmen operated at formal-operational level while 51% and 27% were found, at the concrete

1	2	3	4
	Journal of Research in Science Teaching Vol.12 No.4 pg.347-358, Oct.1975	developmental levels of learners	operational and post-concrete operational levels, respectively.
39.	Somerville S.C. (1974)	The Pendulum problem	Development of formal thought was strongly dependent on age rather than sex and the type of school.
40.	Wenny, C.D. (1974)	Culture and Education versus Acquisition of Formal Operational	Formal thinking was seen promoted by the sub-urban cultural background.
41.	Abramowitz S. (1975)	Understanding of professionality	The nature of content of problems marked difference performance between transitional thinkers, and concrete, as well as, formal stage thinkers on schemes of proportionality.
42.	Bautista, L.B. (1975)	Relationship between Intellectual Levels	Concrete operational students did not differ significantly from formal operational students on concrete thoughts only.
43.	Graybill, L.A. (1975)	Sex difference	Sex differences favouring boys in formal thinking were noticed.
44.	Rajput, D.P. (1975)	Scheme of proportion among certain groups	(i) No significant sex difference were noticed on the scheme of proportion. (ii) Fluctuations in performance were noticed from lower grades to the higher grades with dominating increases of trend with age.

1	2	3	4
45.	Sayre and Ball (1975)	Cognitive Development and Achievement	There was a gradual growth of formal thought among science students in order to complete Piagetian tasks.
46.	Sayre, S. and Daniels, D.S. (1975)	Cognitive Development and Achievement	There was gradual growth of formal thought during adolescence.
47.	Wonsy, L.L. & Cox D.C. (1975)	Task Differences and Formal Operational	Age interacted with the number of variables. A problem becomes more difficult for adolescent pupils to solve if more variables were injected into it.
48.	Vaidya,N. (1975)	Growth of Logical Thinking	(i) Complex thinking processes arose from simple thinking process. (ii) Except occasional fluctuations, mean performance on various schemes of thought showed an increasing trend with grade. (iii) Hump effect was suspected. (iv) Adolescent pupils were not in a position to test hypotheses, contrary to Piaget's views.
49.	Lawson, A.E. & Blake, A.J.D. (1976)	Concrete and Formal Thinking Abilities	About fifty percent of high school biology students did not show formal thought.
50.	Mortorano S.C. (1977)	Development Analysis of Performance	Mean scores on ten tasks increased with grade.
51.	Grewal A. (1978)	Hypothesis testing ability	There was significant relationship between hypotheses testing ability and the creativity variables like fluency and originality.
52.	Shayer, M. and Wylam H. (1978)	Piagetian stages in Britain	There appeared a "study" put in thinking, i.e. beyond the age 15 years, there was no increase in the proportion of pupils showing formal thinking.

1	2	3	4
53.	Kansakar, L. (1979)	Exclusion of variables during Adolescence	(i) Mean performance on all the problems showed an increasing trend in stating and testing of hypotheses with grade. (ii) All the problems were strongly correlated with each other. (iii) Using top 25 percent and bottom 25 percent groups, they were seen to differ significantly from each other in respect of age, and grade, but not in intelligence.
54.	Sandhu T.S. (1980)	Factorial Study of Adolescence Thought	(i) Performance on Piaget type tasks increased. (ii) Boys performed either equal or better than girls on the tasks at respective age levels. (iii) Significant correlation existed between intelligence and adolescent thought and between academic achievement and adolescent thought. (iv) Personality factors played a significant role in development of adolescent thought.
55.	Jain S.C. (1981)	Problem Solving Behaviour in Physics Among Certain Groups of Adolescent pupils	(i) Problem solving ability differed significantly among pupils operating at three levels of intellectual development. (ii) Performance on problems significantly increased after hints were provided.
56.	Mathur, M. (1981)	Growth of Experimental Mind	(i) Performance on Piaget type tasks showed an increasing trend with grade with some fluctuations on certain tasks. (ii) Capacity to grasp essence of the problem increased with grade.

1	2	3	4
57.	Padmini M.S. (1981)	Growth of Exclusion of variables	(i) Adolescent pupils were in a position to state and test hypotheses in all grades. However, mean performance increased with grade with occasional fluctuations. (ii) Many adolescents were found operating at the concrete level. (iii) Majority of successful problem solvers were fourteen year olds and majority of unsuccessful problem solvers were ten year olds.
58.	Manju Jain (1984)	A Study of Logical Thinking among Adolescents	(i) Incidence of concrete thought showed a decreasing trend with age; (ii) Majority of 11+ to 14+ subjects were not in a position to show formal reasoning; (iii) Task performance scores showed an increased trend with age; (iv) No sex differences were shown to have existed.

Summary of the findings

From the above cited works, related to schemes of logical thought, evidence is shown to have accumulated, indicating that children at first lack the capacity to reason logically, coherently, and independently. They gradually acquire the abilities, using past, as well as, informal experiences. Logico-mathematical experiences, and experiences with symbols figures and other concrete objects enhance children's capacity to acquire and master schemes of logical thought, and formal operational thinking.

It is difficult to make a single key statement of the findings, due to their diverse aims and objectives, different sizes of sampled subjects; and diversity of tests, tools, and techniques used. However, assessing the trends, and general purpose, the studies appear to present the following key statements which summarise their main findings. These are : (1) Piaget-type problems (tasks), as given in the Growth of Logical Thinking, and other similar tasks inhering a continuous chain of reasoning measure, schemes of formal thought. (2) Logical structures underlying thought processes are independent of any observation, and show significant relationships with task performances. (3) Significant relationships exist between age, intelligence, higher grades, Piagetian Tasks, and Problem solving scores. (4) Piagetian Task scores of

concrete operational thinkers differ significantly from those of formal operational thinkers when the tasks are administered in a group, providing cross-sectional data. (5) Concrete operational stage prevails among normal adolescent pupils of even upto 20 years of age. The stage concept is supported in principle. (6) Concrete operational thinkers do not differ significantly from formal operational thinkers only, on concrete Piagetian tasks. (7) Formal operational stage correlates, highly with intelligence, and grade, but not with sex, or type of school. (8) Formal thought is necessary to prepositional intelligence, and grade, but not with sex, or type of school. (9) Analytic, as well as, intuitive thinking, and strategy appear, during adolescence. (10) Adolescent thought shows a form of grouping, namely : concrete-operational, and coordinating concrete-logical.
(11) There is a gradual growth of logical thought during adolescence, and there is a 'stay' put in thinking beyond the age of 15 years. (12) Previous classroom experiences appear to play an important factor in separation of variables. (13) Complex thinking processes arise from simple thinking processes. (14) A person is found to have formed a given concept in four thinking styles, namely : Simultaneous scanning; successive scanning; conservative scanning; and focus gambling. (15) Hypothesis testing ability is highly correlated with creativity, language fluency, and originality. (16) Science subjects perform

significantly better on Piagetian tasks of formal operations than subjects of Humanities. (17) Differences of varying degrees exist in logical operation scores of males and females. (18) Quality and content of schemes of logical thought are better determined through effects of mental age, rather than of chronological age. (19) There is no difference between the top 27% group and bottom 27% group on tasks of hypothesis testing. (20) There are common mathematical, or factorial structures underlying Piaget type tasks developed to test schemes of logical thought.

Differentiating Features of the Study

The present study was designed to possess the following features, which concern :

1. Subjects of study : It was proposed to gather for study cross-sectional data from Ugandan adolescent pupils studying in Ugandan schools;

2. The Problem of Study : It was proposed to validate certain Piagetian pre-suppositions on aspects of certain schemes of logical thought using problem solving characteristics;

3. Outside variables : Four outside variables related to aspects of intellectual, numerical, abstract, or spatial, as well as, verbal abilities, were proposed, and selected for study;

4. Homogeneity of Sample : It was proposed to draw a homogeneous sample of same age groups of: 13-14; 14-15; and 15-16 or more, years;

5. __Instruments of study__ : It was proposed to remodify or redevelop existing Piagetian tasks to study aspects of schemes of Piagetian logical operations;

6. __Independent Variables__ : It was proposed to study performance scores of pupils differing in sex, age, grade and parental occupations;

7. __Mathematical structure of the Piaget-type problems__: It was proposed to study mathematical structures, as well as, reliability and validity coefficients of Piaget type-problems modified, re-developed, or developed for the study;

8. __Educational implications__ : It was proposed to enlist educational implications arising from the study.

9. __School system__ : It was proposed to draw, randomly, for the study, Ugandan pupils studying, in upper Primary schools and lower, ordinary level Senior Secondary Schools. Table 2.2 shows the salient features of Uganda's school education system in operation, since 1952;

10. __Scope__ : The study was perceived to be of regional, national, as well as, global flavour planned to avail evidence for developing countries, particularly, in Africa intended to enable them to re-discover themselves in terms of understanding growth; stage-by-stage abilities; and logical, and intellectual capabilities and characteristic behaviours of their children.

Table 2.2

Showing School Education in Uganda Since 1952

Operational Period	Primary Course	Secondary Course	Post-Secondary Course
Upto 1952	Full primary course lasted six years	Full Secondary course lasted six years, made up of (i) three years of junior section and (ii) further three years of senior section	Lasted two and/or more years
From 1953 to 1966	Full primary course lasted eight years; made up of: (i) six years of Primary section, and (ii) further two years of Junior section	Full secondary course lasted six years, made up of : (i) four years of 'O' level and (ii) further two years of 'A' level.	Lasted two and/or more years
From 1967 to - date	Full Primary course lasts, seven years	Full secondary course lasts six years, made of: (i) four years of 'O' level, and (ii) further two years of 'A' level	Lasts two and/or more years

Source : Uganda Teacher's Journal by Hewitt (1939, pp.27-31), African Educational Institutions; Educational Systems of Africa; by Sasnett and Sepmeye (1966).

Aims and Objectives of the Study

The following were the aims and objectives of the study:

1. To validate and extend the study of those basic concepts, forming Professor Jean Piaget's conception of knowledge, using cross-sectional data.

2. To study aspects of schemes of logical thought, through problem solving behaviours.

3. To investigate relationships of performance scores on four standardized tests, and twelve schemes of thought problems; and to study the same : sexwise, agewise, as well as, gradewise.

4. To study performance scores of Ugandan pupils with reference to parental occupations.

5. To investigate relationships between high and low performance scores on schemes of thought problems.

6. To investigate factorial structure of schemes of thought problems.

7. To point out the main educational implications arising from the study.

Formulation of Hypotheses of the Study

Hypotheses are research questions, playing vital roles in generalizing ideas and providing information about the nature of a research area under consideration. They call attention to fundamental causes of relationships

or possible solutions that may arise in an investigation; and, help guide, in the direction, the search is to follow. They are, essentially, of two types, namely; the statistical null hypothesis; and the nonstatistical descriptive hypothesis. The following null hypotheses were formulated for testing, in this study:

1. There are no significant differences: agewise as well as gradewise, in Piagetian cognitive development, of Ugandan pupils tested on, Raven's Progressive Matrices Test, and Differential Aptitude Sub-test, of Numerical Ability.

2. There are no significant differences: agewise, between performance scores of females and males of Ugandan pupils tested, on Raven's Progressive Matrices Test and Differential Aptitude Sub-test of Numerical Ability.

3. There are no significant differences: Agewise, between performance scores of Ugandan pupils, studying in three grade groups (of Primary seven; Senior one; and Senior two) tested, on twelve schemes of thought problems.

4. There are no significant differences: gradewise, between performance scores of females and males of Ugandan pupils, tested on twelve schemes of thought problems.

5. There are no significant differences between performance scores of groups of Ugandan pupils of "Peasant fathers and housewife mothers"; and "others", tested, on twelve schemes of thought problems.

6. There are no significant differences between high and low scores of Ugandan pupils, tested on twelve schemes of thought problems.

7. There does not exist, any factorial structure of adolescent thought in twelve schemes of thought problems administered to Ugandan pupils.

Meaning and Definitions of some Basic Terms, and Concepts of the Study

Piaget's works, especially the publications are, difficult to read, and grasp off-handedly due to equivocal vocabulary and terminologies used, which are highly specialised in meaning and intend. Unless properly mastered, they can hinder, not only meaningful reading, but also distort understanding of the works. They have the peculiarity of uniqueness of purpose, which if lost-sight-of; results in the works being grossly misinterpreted. This is found to be the case with all Piaget-oriented studies. Defined, and in some cases, explained below are, a few of some, of the terms, words, and concepts used in the present study. Following alphabetical order, they include :

Accommodation : meaning process or function which the subject employs, whereby what has been established is modified further in the light of fresh experiences. Used analogously with a dictionary definition-meaning an automatic adjustment of the eye for seeing, at different distances, effected chiefly by changes in the convexity

of the crystalline lens. It is the application of a general scheme to a unique event in which each event changes in every second, and in which there is always an aspect of newness and an aspect of paying attention to the particular. Piaget uses it with the term assimilation to describe the ways in which the organism takes in stimulations; and the organism is modified by it so as to adapt to the assimilated stimulations. Piaget has also described the development of structures through the process of assimilation and accommodation.

Adaptation : the act or result of each individual, becoming adopted to his environment by developing a sufficient repertoire of schemes to deal with the common round of events. It is a fluid state of balance between assimilation of the environment, to the individual and accommodation of the individual to the environment. It is defined as the process and the resultant condition in which changes in an organism, a system of social organisation, group or culture aid, the survival, functioning, maintenance, or achievement of purpose, of the organism, system, group, culture, or of their part thereof.

Adolescent : relating to adolescence; which is the state or process of growing up, or the period of life, from puberty to maturity. Used to describe a stage in human development which occurs in sequence, beginning from the moment of 'conception', and culminating in the stage of

mature human adult. It is the stage which starts from the age of twelve, and continues to sixteen or more years. Encyclopedia of knowledge refers to it as, having no observable beginning or end. It consists of: challenges of personal roles which the individual comes to accept; challenges of being able to think logically; and challenges for the individual to establish good relations with members of the same group. According to the Piagetian conception, it is the stage when the individual has reached formal thinking abilities. He/She is capable of forming hypotheses and deducing possible consequences.

Animism : defined as belief in the existence of a separable soul-entity, potentially distinct, and apart from any concrete embodiment in a living individual or material organism. Used in the expression: "animistic description" - is often used by critiques of Piaget to describe stages of mental development whereby concepts are unrelated to any principle of causality.

Assimilation : meaning process or function which subject employs to absorb, and incorporate new experiences into what he has already established. Biologically, it is the incorporation or conversion of nutrients into photo-plasm that involves both photosynthesis and root absorption. It is the integration of external elements or inputs into existing structures, for which schemes are the instruments. Aspects of knowledge are of operative schemes that allow

impinging stimuli to be psychologically assimilated. Thus, operative is, an aspect of knowledge-by-assimilation and schemes.

Behaviour : meaning the total response: motor, as well as, glandular which an organism makes to any situation with which it is faced. Piaget starts from the assumption that all behaviour, no matter whether it is an external action or an internal one, is in the form of a thought which represents an adoptation. Problem solving behaviours characterise subjects' observed thought processes; thus providing means to study traits of objects observed.

Cognitive Development : covers the period of aspects of conscious development in life. Its study concerns changes with age in relation to the system of what is known and changes in the way in which the system interacts with other facets of behaviour (Flavell, 1977); (McCall, 1981); and (Wohlwill, 1973). Much of cognitive development takes place through the interaction of biology (nature) and environment (nurture) in informal ways (MacCall, 1981). In the Piagetian conception, it is discontinuous in the sense that the functional changes are qualitatively, from one level of development to another. Cognitive development of Non-Piagetian studies include: (1) of Gestalt school whose main interest is of perception, thought to be innately determined; (2) of Vygotsky, whose central idea is language, and inner speech; (3) of Bruner who takes up

the issue of language; and (4) of Information Processing, in which humans are regarded as limited information channels.

<u>Cognitive process</u> : involves, such characteristics as human intellectual function, thinking, planning, knowing, relating, classifying, creating, and problem-solving. Imagination creative fantasy, and intuition, which make it possible to form broad generalized ideas on the nature of objects from observed data play, significant roles in the process of cognition.

<u>Cognitive Style</u> : is defined as individual's characteristic, and consistent manner of processing, and organizing what he sees, and thinks about. Messick (1976) has classified 19 major cognitive styles into three, namely: (1) Cognitive styles which are related to abilities to perform a specific task, and which are assessed in terms of the accuracy or correctness of performance; (2) Cognitive styles which differ in the value which can be attributed to them; and (3) Cognitive styles not related to abilities, and values attributed to them.

<u>Combinatorial analysis</u> : The propositions, as in the case: given p and q that can be neither true nor false, which the individual can group into four groups of the type : (a) both true; (b) both false; (c) p-true q-false; and (d) p-false, and q-true. Their forms of association differ fundamentally from those of true combinations which would fully develop

the sixteen subsets of the four associations two initial propositions which is extentable to 256 ternary operations.

Conservation : meaning retention, is the basis of all memory. Used as retention, it implies nothing beyond the fact or the preservation of form and even a hint of agency. According to the Piagetian conception, it is the stage when speed, distance, length, number, substance, and other entities stand, for constant values or are invariants. The stage is acquired when the child has reached the operational stage.

Equilibrium : (equilibration) is a state, or an act of maintaining an upright position. As a #process, (of equilibration), it defines a stready state of an open system. In the Piagetian conception, it is assumed that the child has no pre-established plan. There is gradual evolution in which each innovation is independent upon the previous one. Adult thought might seem to provide a pre-established model, but the child does not understand adult thought until he has reconstructed it. The process, of equilibration, is disturbed when it renders a series of changes in perception; an equilibrium state is then the active compensation on the part of a child in response to such changes in perception to external disturbances and in which an adjustment is both retrospective and anticipatory, constituting a permanent system of compensations.

Experience : meaning conscious perception or apprehension of reality or of an external, bodily, or psychic event. Used, as, knowledge, it refers to facts or events observed. For Piaget, experience fashions reason and reason fashions experience (Essential Piaget, 1977). Piagetian conception conceptualizes on experience with physical environment, and experience with social environments. Experience with physical environment calls for the role of exercise and acquisition of experience in actions performed upon objects. It is an essential and necessary factor in the formation of logico-mathematical structures, made up of two types of experience, which are; of physical experience, acting upon objects in order to abstract their properties, such as comparing two weights independently of their volumes; and, of logico-mathematical experience acting upon objects with a view to learn the result of the coordination of the actions. Experience of social environment takes place in the course of social interaction and transmission. It is the process of socialization, defined as a structuration to which the individual contributes as much as he receives from it. During transmission, the individual appears most passive, as in school teaching and social action. It is ineffective without an active assimilation by the child, thus presupposing adequency of operatory structures.

Formal Stage : This is the final Piagetian stage of development. It is the stage during which the individual's

mature thought is interacted first in the pre-adolescent period and then continuing through to adolescence. The individual has successfully accomplished the cognitive tasks involved in the concrete operational stage and begins to use formal operations. He can think logically about abstract and hypothetical concepts as well as about concrete situations. Objects no longer need to be present inorder for the reasoning about them to occur. Problems can be context-free. Assumptions rather than concrete objects are acted upon.

INRC : is a Piagetian model or group of four transformations of operations in which

I - represents identity operation

N - represents negation operation

R - represents reciprocity operation, and

C - represents correlative or dual operation.

Logical Thought : Thought is the cognitive process through which objective universe is reflected in concepts, judgements, theories, hypotheses, problem solving and so on, (Donaldson, 1963; and Dixon, 1967); whereas, logical concepts consist of truths derived from laws of logic which are absolute, when their truths of reason are not contradictory to logic, (Leibniz; 1646-1716). In the study of formal logic, acts of thinking, such as, concepts, propositions, inferences, and proof; and, their logical structures are, studied by abstracting concrete content of

thoughts and singling out, the general means by which parts of the content are linked. Logical activities of thought are, therefore, thought processes are effected, in various forms; namely: induction; deduction; analysis; synthesis; construction of hypotheses and theories; and possessing historical, and logical aspects. The historical and logical aspects form the philosophical categories that characterize process of development and of relationships between logical developments of thought and the history of an object, and, history of the processes. The historical form expresses real processes of origin, and formation of given objects; whereas the logical form expresses relationships of laws of connection and interaction of various aspects which exist in an ordered, and developed state. The historical is related to the logical as processes of development during which, connections are successively shaped in the course of history, thereby attaining complete maturity and classical form. In the Piagetian conception, logical thoughts make up the acts of thinking in which, changes in observed data, and situations are the results of, and understood as, propositions which are logically true, or false.

<u>Maturation</u> : is defined as growth due to biological factors, occuring as a consequence of both nature and nurture, especially in the nervous and endocrine system, during organic growth of the individual. Piaget has stated a

number of behaviour patterns dependent on the first functions of certain structures or circuits in the developing individual's coordination of vision and apprehension, which occur at the age of about four and half months, and of the organic conditions for visual and perception found, not fully realised, until adolescence. Maturation plays a role throughout mental and organic growth. It is seen to consist, essentially in opening up new possibilities, and thus, constitutes a necessary but not a sufficient condition for the appearance of certain behaviour patterns. It is reinforced by a functional exercise, and a minimum of experience. It is one of the factors involved, in children's mental development especially when influence of the physical and social milliewx increase in importance with children's growth and maturation.

Operational stage : refers to that state, or being ready for, or in condition, to undertake a destined function. The idea of operational analysis involves capabilities in the determination of concepts through descriptions of the operations employed in using and testing the concepts (Bridgman: 1882-1961). The capacity to learn from experience and adaptation to ones environment are operational abilities. An operational stage in the Piagetian conception is the stage during which, reasoning of the subject is based upon concepts accepted as constant. Adolescents using this form of reasoning allow the possibility of the application of

principles which are characteristics of logical and mathematical operations.

Pre-adolescent : The term plays a key role in the understanding of analysis of adolescent's logical thought. Piaget (1966) uses it to describe the child who is just achieving formal operations, who is encompassed by five transformations which mark the passage from concrete operational level of thought to the stage of formal operations. The transformation entail: the capacity for reasoning on hypotheses-called hypothetico-deductive, used in experiments to formulate certain hypotheses about the nature of the universe; to deduce logical consequences from these hypotheses and then observe the universe to see whether it behaves according to expectations. Subject's answer, at times, in terms of 'may be' are submitted, neither to verification nor experimental proof. The pre-adolescent thinker is found giving replies by concrete propositions of arbitrary signs such as p and q of symbolic logic. He replaces relation between proposition by all sorts of cabolitic signs that logicians usually invent.

Quantitative Knowledge : Quantity is that definiteness of an object owing to which it can be physically or mathematically or mentally divided into homogeneous parts or assembled from those parts. Homogeneity (of similarity or identity) of parts of object is, a distinctive feature of quantity. Differences between similar objects are

quantitative, while differences between dissimilar objects are qualitative. Objects possessing quantitative definiteness have: definite magnitude, number, volume, speed of processes, degree of development of properties, etc. Only after reaching a definite limit for each object do quantitative changes cause qualitative changes. According to Hegel (1770-1831), categories of quantity and quality and their mutual passages initially appear, in an abstract from, then in the absolute idea, only later in nature. Philosophically, analysis of knowledge fall broadly within two categories, namely: qualitative and quantitative. Qualitative analysis encompasses detection of what a material or content is made of; and quantitative analysis encompasses determination of how much of the material or valid information is present.

Schema : is a Piagetian unit of cognitive structure. It represents an internaligation of a class of similar actions or performances. It allows a person to do some mental experiments without committing himself to a course of overt action. It allows for operation on representations of reality so as to deduce problem solving. Schemas are not static, but adaptable, always open to new process of assimilation and accommodation on new environmental situations. They represent the organism's preparation, at any point in time, to adapt to new circumstances and problems. Piaget (1954 and 1966) has defined the term in terms of its

properties, such as: schema is a general idea, applicable to a variety of contents; it is an abstract idea derived from intellectual operations upon objects themselves; and it dependents on the lattice structure and the INRC group. It is the component of figurative knowledge.

Scheme : is an organised, mental or intellectual structure manifested at a given level of development. The term structure is synomymously applied with scheme or schema. In the Piagetian conception of knowledge, schemes from the components of operative processes of knowledge.

Stages : Psychologists divide an individual's period of life span into such modes as: childhood, infancy, adolescence, adulthood and old age; which Freud, Bruner, Erikson and Piaget chose to describe in stages (Kogan, 1978). Piaget (1896-1980) conceptualized on children's epistemological problems, resulting in his stage development of intellectual development, in the individual. According to it a normal human being undergoes, at least four major stages of cognitive development from the moment of birth to the period of adolescence. These are: (1) the sensory-motor stage, manifested during the age range of (0-2) years is, the stage when the individual's behaviour in interaction with the outside world changes, from the first reflex-like forms to motor habits; (2) the pre-operational or pre-logical stage, manifested during the age range of (2-7) years is, the stage when the individual's acquisition

of symbolic functions are actively experienced in the periods of interaction; (3) concrete operational stage, manifested during the age range of (7-11) years is, the stage when the individual has a mobile state of balance in the event of interaction; and (4) the formal operational stage, manifested during the age range of (11-16) years is, the stage when the individual maintains independence and acquires capacity to draw purely formal conclusions from hypothetical assumptions in the events of interaction.

CHAPTER III

PLAN AND PROCEDURE

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Methodology

In its implied sense, methodology of a research describes the scope and methods used, indicating their limitations and data resources. It clarifies aims, objectives, presuppositions and consequences, relating their potentialities to the research advance. In his "Clinical investigations", Piaget lays bare the operational mechanism of thought during problem-solving. Subjects are brought to grips with physical or spatial transformations of materials, when dealing, for example with, problems related to pouring of liquids, from one container to another, or with spatial displacement of rods. The manner of performing them is observed throughout the course of the subjects interactions, and especially when, subjects attempted to overcome conflicts presented by variations and constancies involved in tasks administered. By the method, it is believed that a truer picture of subjects' thoughts is obtained than would if done, by the use of standardized tests. This study made use of correlational,

and normative methods, to explore aspects of schemes of subjects' logical thought.

Subjects of the study

Piaget has not considered sex differences in cognitive development. However, in a round table conference*, held in 1955, Piaget has commented that, boys and girls approach problems related to space, differently. Though Piaget has mentioned only one area: space, the same may be true for other areas of development, as well. Other researchers, Goldschmid (1967) and Fogelman (1970) have noticed sex differences in performance score on Piagetian tasks. But Enswine (1976) did not find significant differences existing sexwise. This study was, therefore, charged, in part, with attempts to study, within Piagetian context, cases involving sex differences.

Age is an important factor in the Piagetian cognitive development. It has been the subject of the majority of Piagetian experimental treatments. Piaget's four main developmental stages: Sensory-motor, pre-operational, concrete operational, and formal operational are, in part, characteristically distinguished by age ranges. Hence the focus, in this study on subjects' ages, aimed at validating and extending the Piaget-oriented studies. The subjects consisted of Ugandan adolescent, pupils studying,

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* Cited by Tanner and Inhelder (1958) in Discussion on Child Development, Vol.III, pp.114, 154-162.

in various sections of Uganda's school Education. Table 3.1 shows levels of the subjects School Education System.

Table 3.1

Showing Uganda's School Education System since 1966

Students Age	Years of schooling	Grading system	
24	19		UNIVERSITY AND OTHER
23	18		POST SECONDARY SCHOOL
22	17		INSTITUTIONS
21	16		
20	15		
19	14		
18	13	S_6	ADVANCED LEVEL
17	12	S_5	SECONDARY SCHOOLS
16	11	S_4	ORDINARY
15	10	S_3	LEVEL
14	9	S_2	SECONDARY
13	8	S_1	SCHOOLS
12	7	P_7	
11	6	P_6	PRIMARY
10	5	P_5	SCHOOLS
9	4	P_4	
8	3	P_3	
7	2	P_2	
6	1	P_1	
5	KINDERGARTEN		
4	EDUCATION		
3			

Source : Sasnet & Sepmeyer (1966)
Educational Systems of Africa

Selection of Subjects

A survey for the subjects was made among Uganda Government managed: Day and Boarding Schools, in and around the township of Arua, (Uganda). Out of 10 Boarding secondary, and 10 Day Primary schools surveyed, five were randomly selected from the Boarding Secondary Schools, and five randomly selected, from the Day Primary Schools. Table 3.2 shows names, levels and types of the schools of the study. A total number of 616 pupils, finally selected participated, in the data collection exercises. Table 3.3 shows the subjects distributed : sexwise, gradewise, as well as schoolwise. Table 3.4 shows their agewise distribution.

Table 3.2

Shows names, levels and types of the schools of the Study

S. No.	Name of school	Level of school	Type of school
1.	Ombaci Primary school	Full P7 school	Day and co-educational
2.	Arua Hill Primary School	Full P7 school	Day and co-educational
3.	Jiako Primary School	Full P7 school	Day and co-educational
4.	Robu Primary School	Full P7 school	Day and co-educational
5.	Kijomoro Primary School	Full P7 school	Day and co-educational
6.	Mvara Senior Secondary	Advanced level Secondary School	Boarding and co-educational
7.	Ombaci Senior Sec. School	Advanced level Secondary school	Boarding boys only

Contd.

S. No.	Name of school	Level of school	Type of school
8.	Ombatini Senior Sec. School	Ordinary level Secondary School	Boarding and co-educational
9.	Ediofe Senior Sec. School	Ordinary level Secondary school	Boarding, Girls only
10.	Muni Senior Sec. School	Ordinary level Secondary school	Boarding, Girls only

Table 3.3

Showing the distribution of the entire population of the subjects schoolwise

S. No.	Name of school	Grade/Class	Sex F	Sex M	Total	
1.	Ombaci P7	7	20	20	40	
2.	Arua Hill P7	7	21	20	41	
3.	Jiako P7	7	20	22	42	
4.	Robu P7	7	18	24	42	
5.	Aijomoro P7	7	18	29	47	
6.	Mvara SS	1B	8	45	53	102
	Mvara SS	2B	13	36	49	
7.	Ombaci SS	1A	-	47	47	95
	Ombaci SS	2B	-	48	48	
8.	Ombatini SS	1B	9	33	42	84
	Ombatini SS	2A	13	29	42	
9.	Ediofe SS	1	50	-	50	96
	Ediofe SS	2B	46	-	46	
10.	Muni SS	2	27	-	27	
	Total : 10	14	263	353	616	

Table 3.4

Showing Agewise distribution of the subjects

Age Groups (in years)	Sexwise		Gradewise			Schoolwise		Total Age group*
	Females	Males	P7	S1	S2	Day	Boarding	
(13-14) % of 616	136 (22.0)	176 (28.6)	96 (15.6)	108 (17.5)	108 (17.5)	96 (15.6)	216 (35.0)	312 (50.6)
(14-15) % of 616	79 (12.8)	97 (15.8)	70 (11.4)	51 (8.3)	55 (8.9)	70 (11.4)	106 (17.2)	176 (28.6)
(15-16 or more) % of 616	48 (7.8)	80 (13.0)	46 (7.5)	33 (5.4)	49 (7.9)	46 (7.5)	82 (13.3)	128 (20.8)
Totals: % of 616	263 (42.7)	353 (57.3)	212 (34.4)	192 (31.2)	212 (34.4)	212 (34.4)	404 (65.6)	616 (100.0)

* According to table 3.4, half of the subjects were aged (from 13-14) years; and, the remaining half, were aged (from 14-16 or more) years.

Instruments of the study

A survey of Piaget-type tasks was made in order to select suitable tasks for studying the subjects. Though a large number of such written Piaget type problems: reviewed, standardised and used on American and British children was available, it was found necessary to select those problems redesigned under the guidance of Professor N.Vaidya (Vaidya, 1979) and (Vaidya and Jain, 1982). These problems were standardised and used on Indian children. More than fifteen of the problems were at first redeveloped, but after a pilot study was conducted, several of them underwent further modification so as to suit Ugandan school education situations. At the end, twelve of them were finally adopted for use, consisting of 74 thinking processes. Table 3.5 shows their list, of which, the last four problems are non-Piaget-type.

Table 3.5

Showing names and coded numbers of the instruments of the study

S.No.	Name	Coded number
1.	Water in beakers problem	Prob-1
2.	Common Differences Problem	Prob-2
3.	Intersection Problem	Prob-3
4.	Abstract Counter Problem	Prob-4
5.	Weight comparison Problem	Prob-5
6.	Two front Division Problem	Prob-6

S.No.	Name	Coded number
7.	Length of Shadow Problem	Prob-7
8.	Flow of Liquid Problem	Prob-8
9.	Joker's cards Problem	Prob-9
10.	Nine Dots Problem	Prob-10
11.	Think Things Out Problem	Prob-11
12.	Balance and Step-by-Step Measurement Problem	Prob-12
13.	Raven's Progressive Matrices Test	RMT
14.	Numerical Abilities Test	NAT
15.	Abstract Reasoning Test	ART
16.	Verbal Reasoning Test	VRT

Sampling Design

A sampling design is decided, in the light of what is practically feasible as well as what is theoretically desirable. In considering these matters, due regard is given to aims and objectives of the research studies, the accuracy required in the results, time and budget estimates, labour involved and other practical considerations expected in the course of experimental, statistical, and analytic treatments of the study.

The method of restricted random sampling was adopted in the sampling design. Note was taken of previously known ratios, such as 30% by 70% (for Day and Boarding Schools respectively) in Uganda; 50% by 50% (for sex distribution in

a Day Primary class), in Uganda; and 25% by 75% (for sex distribution in Boarding Secondary classes), in Uganda. The principle of randomization was strictly adhered to in securing the partial coverage* (of 270 pupils) for the study. According to Garett (1966), in the event of the subjects in an original sample not being easily accessible to sampling, even after "ratios of stratification and use of the method of restricted random sample are available, a further method of: normality of distribution of certain psychological traits is, desirable.

Accordingly, Numerical Ability Test scores of the entire population (of 616 pupils) were matched, sexwise, agewise, as well as, gradewise** with Age Norms*** of standardised Differential Aptitude Tests, of Numerical Ability Test. Appendix c (column 2) shows Age Norms for Numerical Ability Test, utilized. Subjects whose raw scores were equal to, or around the normed mean values of Numerical Ability Test were selected. Tables 3.6 through to 3.9 show details of the sampled subjects.

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* The partial coverage took note of the trend of Ugandan School population pattern since 1952 reported by de Bunsen Report (1953).

** An examination of placement Recommendations by the Council on Evaluation of Foreign students credentials (July 1965 and April, 1966) has placed the three study groups, P7; S1; S2, as equivalents of grades: 8; 9; 10.

*** Manasayan Publications (New Delhi) issue DAT Directions for Administration and Scoring which, contain Norms in Percentile Mean and Standard Deviation values for both sexes, covering grades 8 through 12, (See Appendix C).

Table 3.6

Showing agewise distribution of the study sample

S. No.	Age groups (in years)	Females Cases	%	Males Cases	%	Total Cases	%
1.	(13-14)	29	4.7	61	9.9	90	14.6
2.	(14-15)	29	4.7	61	9.9	90	14.6
3.	(15-16)	29	4.7	61	9.9	90	14.6
	Total	87	14.1	183	29.7	270	43.8

Table 3.7

Showing gradewise distribution of the study sample

S. No.	Age groups (in years)	Females Cases	%	Males Cases	%	Total Cases	%
1.	Primary seven (P7)	39	6.3	39	6.3	78	12.6
2.	Senior One(S1)	24	3.9	72	11.7	96	15.6
3.	Senior Two(S2)	24	3.9	72	11.7	96	15.6
	Total	87	14.1	183	29.7	270	43.8

Table 3.8

Showing schoolwise distribution of the study sample

S. No.	Type of school	Females Cases	Females %	Males Cases	Males %	Total Cases	Total %
1.	Day schools	39	6.3	39	6.3	78	12.6
2.	Boarding schools	48	7.8	144	23.4	192	31.2
	Total	87	14.1	183	29.7	270	43.8

Table 3.9

Showing distribution of the study sample with reference to parental occupations

S.No.	Occupations of parents	No. of cases	%
1.	Peasants and housewives	165	26.8
2.	Professionals, managerials and others	105	17.0
	Total	270	43.8

Processing and Statistical Treatment of the Research Data

A major portion of the statistics of the research was computerised, using: S.P.S.S. Package HAYAD - 1022 Computer, in order to facilitate transformation of the raw scores obtained into statistical entities. The process entailed preparation of a Computer Code Book, and "Computer Programme of Instructions". Appendix D shows details of

the Planned Statistical Treatment.

Variables of the study

The research data were collected using various instruments and procedures already described in the foregoing sections of this chapter. Treatment was given to ninety three variables. The following, tabulated, (in table 3.10) is the full list* of the variables.

Table 3.10

Showing list of the variables of the study

No. of variables of the study	Description	Abbreviation
1.	Sex	SEX
	Category-1 (Female)	
	Category-2 (Male)	
2.	Age (in years)	AGE
	Category-1 (13-14)	
	Category-2 (14-15)	
	Category-3 (15-16)	
3.	Grades	GRADE
	Category-1 (Primary seven - P7)	
	Category-2 (Senior one - S1)	
	Category-3 (Senior two - S2)	

*Instructions for their computer analysis are shown in Appendix D.

4.	<u>Type of school</u>	TYPE OF SCH
	Category-1 (Day)	
	Category-2 (Boarding)	
5.	<u>Father's occupation</u>	FATHER OCCUP
	Category-1 (Peasants)	
	Category-2 (Professionals and Managerials)	
	Category-3 (Skilleds & Craftsmen)	
	Category-4 (Unskilleds and Group employees)	
	Category-5 (Clergy and Laity)	
6.	<u>Mother's occupation</u>	MOTHER OCCUP
	Category-1 (Peasants & Housewives)	
	Category-2 (Professionals and Managerials)	
	Category-3 (Skilled & Crafts-women)	
	Category-4 (Unskilleds and Group employees)	
	Category-5 (Clergy & Laity)	
7.	Progressive matrices Test	PMT
8.	Numerical Ability Test	NAT
9.	Abstract Reasoning Test	ART
10.	Verbal Reasoning Test	VRT
11.	Total scores on standardised tests	TOTALS ST
12.	Water in Beakers Problem	Prob-1
13.	Common Differences Problem	Prob-2
14.	Intersection Problem	Prob-3
15.	Abstract counter Problem	Prob-4
16.	Weight Comparison Problem	Prob-5
17.	Two Front Division Problem	Prob-6

18.	Length of Shadow Problem	Prob-7
19.	Flow of Liquid Problem	Prob-8
20.	Joker's cards Problem	Prob-9
21.	Nine Dots Problem	Prob-10
22.	Think Things out Problem	Prob-11
23.	Balance and step by step measurement Problem	Prob-12
24.	Total Scores on Schemes of thought Problems	TOTAL PROBS
25.	Amount of water in beaker B is more than that in beaker C: Yes or No?	Prob-1.1
26.	Amount of water in beakter C is the one more: Yes or No?	Prob-1.2
27.	Amount of water in both beakers are the same: Yes or No?	Prob-1.3
28.	Volume of water in beaker B is more than that in water C: Yes or No?	Prob-1.4
29.	Volume of water in beaker C is the more: Yes or No?	Prob-1.5
30.	Volume of water in both beakers B & C are the same: Yes or No?	Prob-1.6
31.	Value d_1 obtained by getting the common difference across the given pattern of numbers is:	Prob-2.1
32.	Value d_2 obtained by getting the common difference downwards in the given pattern of number is:	Prob-2.2
33.	Number A in the pattern stands for:	Prob-2.3
34.	Number B in the pattern stands for:	Prob-2.4
35.	Number C in the pattern stands for:	Prob-2.5
36.	Intersection I, shown in the figure is made up of the male people with the city people, i.e. MnC=I; Yes or No?	Prob-3.1

37. Intersection I shown in the figure is made up of the yellow people with the city people i.e. Y∩C=I; Yes or No? Prob-3.2

38. Intersection I shown in the figure is made up of the male people with yellow people, i.e. Y∩M=I; Yes or No? Prob-3.3

39. Intersection I shown in the figure is made up of the city people, the yellow people and the male people i.e. C∩Y∩M=I; Yes or No? Prob-3.4

40. How many lines has the given figure? Prob-4.1

41. What is the maximum number of the rectangles seen in the figure? Prob-4.2

42. How many rooms are there, if the figure represents a building foundation? Prob-4.3

43. In the given photograph, block C is lighter than block B; Yes or No? Prob-5.1

44. In the given photograph, block C is lighter than block A; Yes or No? Prob-5.2

45. In the given photograph, Block A is heavier than blocks B & C put together, Yes or No or Depends? Prob-5.3

46. The blocks can be arranged according to their order of weight, starting from light then lighter and finally lightest; Yes or No? Prob-5.4

47. Using the letters A, B and C arrange the blocks from heaviest to heavy or lightest to light. Prob-5.5

48. What is the group made up of senior one boys and senior one girls in the given figure called? Prob-6.1

49. What is the group made up of senior one students and the rest of the students in the school in the given figure called? Prob-6.2

50. What is the group made up of students in the school and the outsiders, in the given figure called? Prob-6.3

51. What is the group made up of senior one students and senior one girls, in the given figure called? Prob-6.4

52. What is the group made up of senior one boys who are football players and senior one boys who are not football players in the given figure called? Prob-6.5

53. Judging from the length of the shadow cast by the objects, the moment was in the evening; Yes or No? Prob-7.1

54. Judging from the length of the shadow cast by the objects, the moment was in the morning; Yes or No? Prob-7.2

55. Judging from the length of the shadow cast by the objects the moment was at noon; Yes or No? Prob-7.3

56. Amount of liquid collected in beaker B will be more or less if the size of the glass tube changed; Yes or No? Prob-8.1

57. Liquid collected in beaker B will be more if beaker A remained constantly filled up; Yes or No? Prob-8.2

58. Liquid collected in beaker B will be more if the glass tube is thick; Yes or No? Prob-8.3

59. Liquid collected in beaker B will be more if the glass tube is long; Yes or No? Prob-8.4

60. Liquid collected in beaker B will be more if beaker A is placed at a higher position than beaker B; Yes or No? Prob-8.5

61. Why should more liquid be collected in beaker B if the beakr A remained constantly filled up? Prob-8.6

62. Chances of picking cards marked with Jokers in the first show is: Prob-9.1

63. Chances of picking cards marked with Jokers in the second show is: Prob-9.2

64. Chances of picking cards marked with Jokers in the third show is: Prob-9.3

65. Chances of picking cards marked with Jokers in the fourth show is: Prob-9.4

66. Is it in the first, second, third or fourth show that the chance is the greatest? Prob-9.5

67. State the rules for telling where chance (P) of picking cards marked with jokers lie is obtained. Prob-9.6

68. A drawing to cover the first given set of nine dots with four straight lines is: Prob-10.1

69. A drawing to cover the second given set of nine dots with four straight lines is: Prob-10.2

70. A drawing to cover the third given set of nine dots with four straight lines is: Prob-10.3

71. A drawing to cover the fourth given set of nine dots with four straight lines is: Prob-10.4

72. Another similar drawing, to cover self constructed set of nine dots is: Prob-10.5

73. A second similar drawing to cover a second set of self constructed nine dots is : Prob-10.6

74. How many drops are there when a drop is added to another drop? Prob-11.1

75. How many corners are left when one corner of any handerchief is cut off? Prob-11.2

76. How many birds are left sitted when a hunter shoots dead two birds out of eighty? Prob-11.3

77. If two ducks are seen swimming in front two behind and two in the middle, how many ducks are there altogether? Prob-11.4

78. When four years agos, my father's age was 3 times mine now my father is 36-4 years old, Yes or No? Prob-11.5

79. When four years ago, my father's age was 3 times mine now my father is 36+4 years old, Yes or No? Prob-11.6

80. When four years ago, my father's age was 3 times mine now my father is 3x16 years old, Yes or No? Prob-11.7

81. When four years ago, my father's age was 3 times mine, now my father is not as old as already afore expressed, Yes or No? Prob-11.8

82. The disimilar or the stranger in the set of numbers 15, 26, 9, 71, 84, 90 is : Prob-11.9

83. The disimilar or the stranger in the set of letter A, L, Y, A, B, M is : Prob-11.10

84. When weights of 3 kilos (kg) and 5 Kilos (kg) are put together and hung on one side of a weighing machine the weight of meat needed to balance these weights should be 3x5; Yes or no? Prob-12.1

8$. When weights of 3 kilos (kg) and 5 kilos (kg) are put together and hung on one side of a weighing machine the weight of meat needed to balance these weights (in kg), should be 3+5; Yes or No? Prob-12.2

86. The first step towards filling beaker A, using the two given beakers B_1 and C_1 is : Prob-12.3

87. The second step towards filling beaker A, using the two given beaker B_1 and C_1 is: Prob-12.4

88. The third step towards filling beaker A, using the two given beaker B_1 & C_1 is : Prob-12.5

89. The fourth step towards filling beaker A_1 using the two given beakers B_1 and C_1 is: Prob-12.6

90. The fifth step towards filling beaker A_1 using the two given beakers B_1 and C_1 is: Prob-12.7

91. The sixth step towards filling beaker A_1 using the two given beakers B_1 and C_1 is: Prob-12.8

92. The seventh step towards filling beakers A_1 using the two given beakers B_1 and C_1 is : Prob-12.9

93. Total of thinking processes scored right : TOTALS THOUGHT PROCESSES

<u>Some Aspects of Problem Solving</u>

Theory of problem solving has an important place in the teaching and learning processes. It offers the frame work or the pattern, within which thinking and thought take place. Problem solving provides detailed characteristics of the behaviour of human subjects confronted with tasks; and technologically, problem-solving proclaims man to be an information processing system, at the time of solving problems. In Science Education Problem solving is a process popularly employed. It is regarded as a technique or method of: teaching and learning; concept formation; concept development; and acquisition of scientific concepts. According to Stoll (1956), problem solving is not a series of fixed steps described in science texts from three to four or upto ten steps in number. It is an assortment, but not a pattern of skills, attitudes and habits. Stoll (op.cit) argues that, it is only when, the individual has a reasonable

command of certain, well selected facts, important principles, and broad generalizations related to the problem, can he arrive at a better conclusion, and will do it quicker, than a person who, is not familiar with the general field of the problem. For Vaidya (1966), problem solving is a goal oriented activity, with no direct solution available to the solver at the time of its presentation and which takes place as soon as the solver perceives the problem. Vaidya (op.cit) maintains that possession of basic information, needed to solve the problem by the solver, is a pre-requisite. If his definition is un-veilded, it is seen to encompass the dual conceptions enshrinded in what is known, as: resolution of problems or tasks; and problem solving, proper. Hence, definition of problem solving varies, ranging from that of the "simple finding, of exceptions", (cf Nesbit, 1930), to that of "formal reasoning, of a complex nature", (of Inhelder, 1962). According to Vaidya (op.cit.), we can have as examples, subjects like dogs, cats and rats solving problems, say in Pavlovian, Skinner or Thorndikian Puzzle boxes and mazes, as well as, human beings, resolving or solving, advanced problems, involving fundamental concepts of mass of volume, length, space or time in life and Educational Institutions.

In his comprehensive summary of all available studies on concepts of thinking, and logical steps in problem solving, Professor Vaidya (1982) defined, thinking, as a

mental activity applied, in determining a course of ideas, feeling, formulation, and assertion of proportions, percepts, and vocal sound". He took to task academic and professional psychologists from European, as well as, American continents for having investigated thinking, from several varied stand points, while paying little attention to problems of classroom instructions. Educational psychologists too, according to Professor Vaidya have examined through the medium of problem solving scores of scientific issues but with the actual process of thinking eluding their attention. To illustrate he cited the findings of such workers as: (1) Spearman (1904 and 1927) which regarded the "apprehension of experience, education of relations, and education of correlates", quite sufficient for explaining the entire spectrum of intellectual behaviours; (2) Humphreys (1962 and 1970) which equated thinking with problem solving, which contained a hierachy of thinking abilities, made up of relations, associations, perceptions and sensations. (3) Russell (1926, 1948 and 1956) which suggested schemes, starting with stimulus patterns (internal or external), passing through materials of thinking, and taking as exampler, perceptual thinking, associative thinking, problem solving and creative thinking, in order to arrive at conclusions; (4) Maltzman (1956) who distinguished differences between reproductive and productive thinking.

In the Piagetian view the child's ability to solve problems depends on the one hand, on the nature of particular

problem, and on the other, on his own intellectual structure. Most psychological studies on problem solving have been concerned with the outcome of these intellectual processes. Others have studied the nature of processes by which the child attempts to adopt himself to new situations which call for his elaboration on the problems. Piaget (1926 & 1929; 1927 & 1930) undertook to study systematically, thought contents of the child, and development of the different ways in which children represent and explain phenomena, in situations not involving conflict. He dealt with the workings of simple machines such as the bicycle, as well as, with more complex notions derived from physical and psychological experience, such as: origins of names and their relation to objects, naming of movements of stars and clouds, and attribution of consciousness and life, to living beings or to objects. This way Piaget was in a position to establish an inventory of children's beliefs and explorations, and to evaluate their authenticity, and to distinguish trends followed in the course of their development.

Characteristics of Piaget-type Problems

In order to study logical thinking among certain groups of Ugandan adolescent pupils it was proposed to develop or re-design, a written test instrument typical of Piagetian tasks for the study. Piaget type tasks are the set of tasks, re-designed or further modified from the

original tasks or problems used by Piaget, and his co-workers, in original experiments. Several of them are now being modified or re-designed. The tasks provide a theoretical framework that focuses on developmental sequences, and have a procedural approach characterized by flexibility and qualitative interpretation (Anastasi, 1968). The Piagetian problems are ordinal. They presuppose a uniform sequence of development through successive stages. They are content-free, in so far as they provide qualitative descriptions of what the subject is actually able to do. They focus on the long-term development of specific concepts rather than on broad traits. With regard to administration, the major object is to elicit subject's explanation for an observed event and the reasons that underlie the explanation. Scoring is characteristically based on the quality of the childs responses to a relatively small number of problem situations presented to him, rather than on the number or difficulty of successfully completed items. The examiner concentrates more on the process of problem solving than on the product.

Laurendeau and Pinard are engaged in an unusually comprehensive, long-term research project designed to replicate Piaget's work under standardized conditions with large representative samples, and in a different cultural milieu (Laurendeau and Pinard, 1962, 1970 and 1964). In the course of their investigations, they have administered a

battery of 57 tests to 700 children ranging in age from 2 to 12 years. Their problems include such tasks as : (1) recognising objects by tough and identifying them among visually presented drawings of the same objects; (2) arranging a set of toy lamp posts in a straight line between two toy houses; (3) placing a toy man in the same spots in the subject's landscape that he occupies in the examiner's identical landscape; (4) designating right and left on the subject's body, on the examiner, in different positions, and in relation to objects on the table; and (5) problems of perspective systems in which the subject indicates how three toy mountains look to a man standing in different places. Inter-correlation coefficients for their tasks have ranged from 0.59 to 0.78; and correlations ranged from 0.38 to 0.67 (Laurendeau & Pinard, 1962, & 1970).

In India, a number of studies conducted under the guidance of Professor N. Vaidya, using Piaget-type tasks include those of Misra (1975) and Jain (1982) which found significant correlations existing between the various Piaget-type tasks; of Padmini (1982), conducted on the adolescent thought, using only one dimension, of the exclusion of variables; and of Manju Jain (1984) which studied logical thinking among pupils in Ajmer City.

<u>Twelve Schemes of Thought Problems of the Study</u>

The present study proposed to investigate aspects of over ten schemes of logical thought. The schemes included: (1) Conservation of Volume; (2) Using Common Differences; (3) Combinatorial Analysis; (4) Observation, related to perspective System; (5) Seriation; (6) Classification; (7) Proportionality; (8) Stating Hypotheses; (9) Probability; (10) Insightful figural knowledge; (11) Grasping the Essence of the Problem; and (12) Generalised Logical Thought. Each scheme had a Piaget-type problem (herein after referred to as schemes of thought problem) designed or modelled to elicit subject's logical thinking processes. Table 3.11 shows the schemes of logical thought each paired, with its respective Piaget-type problem. The total number of items in each scheme problem are also indicated. Table 3.12 shows the scoring schemes for each of the problems along with the maximum marks assigned for each of the problems.

Contd.

Table 3.11

Showing Schemes of Logical Thought along with their Respective Problems

Problem Number	Schemes of Logical Thought	Name of the Problem of Scheme of Thought	Number of items
1.	Conservation of volume	Water in beakers	9
2.	Using Common Differences	Common Differences	5
3.	Combinatorial Analysis	Intersection	4
4.	Observation in Coordinated Perspective systems	Abstract Counting	3
5.	Seriation	Comparison of weights	5
6.	Classification	Two front Division	5
7.	Proportionality	Length of shadow	3
8.	Stating Hypotheses	Flow of liquid	6
9.	Probability	Joker's cards	8
10.	Insightful knowledge	Nine Dots	7
11.	Grasping Essence of Problems	Think Things out	10
12.	Generalised Logical Thought	Balance and step-by-step measurement	9
Total	12	12	74

Table 3.12

Showing marking schemes for each of the Twelve Schemes of Thought Problems

S.No. of items	Thinking Process or questions	The scoring scheme
	Problem 1	
1.	Level of water in beaker B is higher than the level in C. Yes or No?	One mark for a correct response
2.	Level of water in beaker C is the one higher than that in B. Yes or No?	One mark for a correct response
3.	Levels of water are equal in both beakers. Yes or No?	One mark for a correct response
4.	Amount of water in beaker B is more than that in beaker C. Yes or No?	One mark for a correct response
5.	Amount of water in beaker C is the one more. Yes or No?	One mark for a correct response
6.	Amounts of water are the same in both beakers. Yes or No?	One mark for a correct response
7.	Volume of water in beaker B is more than that in beaker C. Yes or No?	One mark for a correct response
8.	Volume of water in beaker C is the one more than that in beaker B. Yes or No?	One mark for a correct response
9.	Volume of water in both beakers B and C are the same. Yes or No?	One mark for a correct response
	Maximum number of mark scoring items	9

Problem 2

1.	Value of d_1 obtained by getting the common difference across the given pattern of number is :	One mark for a correct response
2.	Value of d_2 obtained by getting the common difference downwards in the given pattern of number is :	One mark for a correct response
3.	Number of A in the pattern stands for :	One mark for a correct response
4.	Number of B in the pattern of numbers stands for :	One mark for a correct response
5.	Number of C in the pattern stands for :	One mark for a correct response
	Maximum number of mark scoring items	5

Problem 3

1.	Intersection I shown in the figure is made up of the male people with the city people (i.e. $M \cap C = I$). Yes or No?	One mark for a correct response
2.	Intersection I shown in the figure is made up of the yellow people with the city people (i.e. $Y \cap C = I$). Yes or No?	One mark for a correct response
3.	Intersection I shown in the figure is made up of the male people with yellow people (i.e. $Y \cap M = I$). Yes or No?	One mark for a correct response
4.	Intersection I shown in the figure is made up of the city people, the yellow people and the male people (i.e. $C \cap Y \cap M = I$). Yes or No?	One mark for a correct response
	Maximum number of mark scoring items	4

Problem 4

1.	How many lines has the figure?	One mark for a correct response
2.	What is the maximum number of the rectangles seen in the figure?	One mark for a correct response
3.	How many rooms are there if the figure represented a building foundation?	One mark for a correct response
	Maximum number of mark scoring items	3

Problem 5

1.	In the given photograph, block C is lighter than block B. Yes or No?	One mark for a correct response
2.	In the given photograph, block C is lighter than block A. Yes or No?	One mark for a correct response
3.	In the given photograph, block A is heavier than blocks B and C put together. Yes or No or Depends?	One mark for a correct response
4.	The blocks can be arranged according to their weights, starting from light, then lighter and finally lightest. Yes or No?	One mark for a correct response
5.	Using the letters: A, B and C arrange the blocks from heaviest to heavy or lightest to light.	One mark for a correct response
	Maximum number of mark scoring items	5

Problem 6

1.	What is the group made up of senior one boys and senior one girls called?	One mark for a correct response
2.	What is the group made up of senior one students and the rest of the students in the school called?	One mark for a correct response
3.	What is the group made up of students in the school and the outsiders, called?	One mark for a correct response
4.	What is the group made up of senior one students and senior one girlis called?	One mark for a correct response
5.	What is the group made up of senior one boys who are football players and senior one boys who are not football players, called?	One mark for a correct response

Maximum number of mark scoring items	5

Problem 7

Judging from the length of shadows cast or otherwise, estimate the time or the moment when the shadows were cast :

1.	Was it in the evening? Yes or No?	One mark for a correct response
2.	Was it in the morning? Yes or No?	One mark for a correct response
3.	Was it in noon? Yes or No?	One mark for a correct response

Maximum number of mark scoring items	3

Problem 8

1.	Amount of liquid collected in beaker B will be more or less if the size of the glass tube was changed. Yes or No?	One mark for a correct response
2.	Liquid collected in beaker B will be more if beaker A remains constantly filled up. Yes or No?	One mark for a correct response
3.	Liquid collected in beaker B will be more if the glass tube was thick. Yes or No?	One mark for a correct response
4.	Liquid collected in beaker B will be more if beaker A is placed at a higher position than of beaker B. Yes or No?	One mark for a correct response
5.	Liquid collected in beaker B will be more or less if the glass tube is long. Yes or No?	One mark for a correct response
6.	Why should more or less liquid be collected in beaker B if beaker A was or was not constantly filled up?	One mark for a correct response
	Maximum number of mark scoring items	6

Problem 9

Arising from the calculations in the (given) table the chances of picking cards with jokers in :

1. (a) The First show is :
2. (b) The second show is :
3. (c) The third show is :
4. (d) The fourth show is :

One mark for each correct response

5.	Is it in (a) or (b) or (c) or (d) that the chance is the greatest?	One mark for a correct response
6.	What is the numerical value of this greatest chance?	One mark for a correct response
7.	Arrange the chances of picking cards marked with jokers in increasing or decreasing order.	One mark for a correct response
8.	State a rule by which you can tell where chance of picking cards marked with jokers lies.	One mark for a correct response
	Maximum number of mark scoring items	8

Problem 10

1.	Four straights lines to cover	One mark for each correct response
2.	four sets of nine dots so that	
3.	the lines cover the dots in	
4.	each case are :	
5.	Two more sets of nine dots for which to draw four straight	One mark for each correct response
6.	lines in each case so as to form patterns differing from those above are:	
7.	Straight lines to join a different arrangement of four sets of nine dots shown in the figures and to name the minimum number of lines obtained when joining any one of four sets (Cris-crossing, being allowed) is :	One mark for any correct response
	Maximum number of mark scoring items	7

Problem 11

1.	How many drops are there when a drop is added to another drop?	One mark for a correct response
2.	How many corners are left when one corner of an handkerchief is cut off?	One mark for a correct response
3.	How many birds are left sitted when a hunter shoots deads two birds out of eighty?	One mark for a correct response
4.	If two ducks are seen swimming in front, two behind, and two in the middle, how many ducks are there altogether?	One mark for a correct response
	If four years ago, my father's age was 3 times mine I am now 36-years old can I say that, now	
5.	(a) My father is 36-4 years old Yes or No?	One mark for each correct response
6.	(b) My father is 36+4 years old Yes or No?	
7.	(c) My father is 3x16 years old Yes or No?	
8.	(d) My father is not as old as expressed in (a), (b) and (c) Yes or No?	
	Spot the dissimilar or the stranger in the following :	
9.	(a) 15, 26, 9, 71, 84, 90	One mark for each correct response
10.	(b) A L Y K b M	

Maximum number of mark scoring items	10

Problem 12

When weights of 3 kilos (kg) and 5 kilos (kg) are put together, and hung on one side of a weighing machine (Mizani) the amount of meat needed to balance the weights of these stones (in kg) is :

1.	(a) 3x5. Yes or No?	One mark for each correct response
2.	(b) 3+5. Yes or No?	
3.	(c) None of (a) and (b) Yes or No?	
4.	When beaker A (of capacity 13 cc)	One mark for each correct logical step
5.	is fixed, and two other beakers B_1	
6.	(of capacity 9 cc), and C_1 (of	
7.	capacity 5 cc) are used to fetch	
8.	water for filling beaker A_1,	
9.	logical steps, at least six, or seven, needed are :	

Maximum number of mark scoring items	9

Sample solutions of Twelve Schemes of Thought Problems

The twelve schemes of thought problems of the study were manually marked and scored. Subjects, whose answers were identical to the sample solutions were awarded marks according to the schemes of formulae for scoring contained in Table 3.12. A complete list of the sample solutions are shown in Table 3.13.

Table 3.13

Showing Sample Solutions of the Twelve Schemes of Thought Problems

Prob.1		Prob.2		Prob.3		Prob.4		Prob.5		Prob. 6	
Item No.	Sample Answer	Item No.	Sample Answer	Item No.	Sample Answer	Item No.	Sample Answer	Item No.	Sample Answer	Item No.	Sample Answer
1.	Yes	1.	3	1.	No	1.	9	1.	Yes	1.	Senior one students
2.	No	2.	4	2.	No	2.	11	2.	Yes	2.	Students in the school
3.	No	3.	17	3.	No	3.	6	3.	Depends	3.	Population or human
4.	No	4.	18	4.	Yes			4.	Yes	4.	Senior one students
5.	No	5.	27					5.	A,B,C, or C,B,A	5.	Senior one boys
6.	Yes										
7.	No										
8.	No										
9.	Yes										
	9		5		4		3		5		5

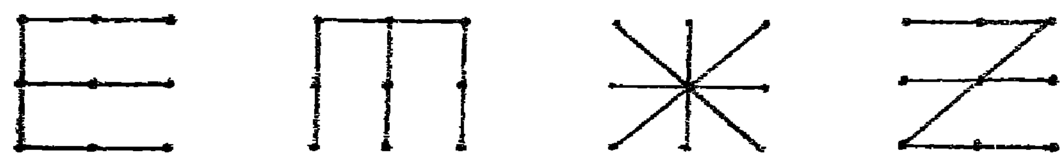
Prob.7		Prob.8		Prob.9	
Item No.	Sample Answer	Item No.	Sample Answer	Item No.	Sample Answer
1.	Yes	1.	Yes	1.	8/11 = 0.727
2.	Yes	2.	Yes	2.	7/9 = 0.778
3.	No	3.	No	3.	6/9 = 0.667
		4.	Yes	4.	7/10 = 0.700
		5.	No	5.	In (b)
		6.	More liquid exerts more pressure and hence more liquid flows. The converse is true.	6.	7/9 = 0.778
				7.	6/9;7/10;8/11;7/9
				8.	P = n/N and defines or describes n-standing for chances of events of jokers; and N-standing for the totals of events (Joker and non-Joker cards)
	3		6		8

ITEM Nº

PROB — 10

SAMPLE SOLUTIONS

1.
2.
3.
4.

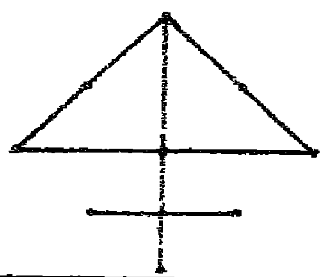


(A) (B) (C) (D)

5.
6.

(A) (B)

7.



7.

Prob. 11 Item No.	Sample Answer	Prob. 12 Item No.	Sample Answer
1.	One	1.	No
2.	Five	2.	Yes
3.	None	3.	No
4.	Four	4.	To ensure C_1 is empty and B_1 is filled with water
5.	No	5.	Fill C_1 with water poured from B_1
6.	Yes	6.	Pour away water filled in C_1
7.	No	7.	Transfer remaining 4 cc of water from B_1 into C_1
8.	No	8.	Fill B_1 to the brim with water
9.	9	9.	Pour water from both beakers C_1 (4 cc) and B_1 (9 cc) into beaker A_1 (of 13 cc capacity)
10.	B		
	10		9

Total of processes : 31 + 17 + 26 = 74

_ Analysis of Twelve Schemes Thought Problems_

Calculating the Reliability Coefficient

Reliability of a test is an index showing stability trustworthiness of the test scores. Several methods ..., for the calculation of the reliability index or ...fficient, depending on the type of administration, from scoring schemes of the test scores. They include the ...hod of: correlating scores on two different test forms ...n on two different occasions; correlating scores on ...titions of the same test form; correlating scores on test forms given on the same occasion; and measuring the ...rnal consistency of a test, possessing one form, and ...inistered on the same occasion. Kuder and Richardson ...37) method measures internal consistency of test scores, was therefore, employed in the calculation of the ...sent study's reliability coefficients of twelve, schemes thought problems. The following formula (3.1) was used the calculation of the reliability coefficients, which is:

$$r_{ii} = \frac{n}{N-1}\left\{1 - \frac{\sum(X_{ni})(X_{ai})}{N(N-1)\,S_i^2}\right\} \quad \ldots.(3.1)$$

which,

- represents reliability coefficient for problem i, (i = 1, 2, 3, ... 12);
- represents the number of individuals attempting the problems (or the entire study sample);
- represents the total number of items in individual problems;

p_i	-	represents the proportion of individuals answering the ith item correctly;
q_i	-	$(1-p_i)$, represents the proportion of individuals not answering the ith item correctly;
N_{pi}	-	represents the number of individuals answering the ith item correctly;
N_{qi}	-	represents the number of individuals not answering the ith item correctly;
S_i	-	represents the variance, (S.D.) of individual problems.

Table 3.14 shows the calculated reliability coefficients.

(2) <u>Calculating the Validity Coefficient</u>

Point biserial,(r_{pbi}), Correlation method was used for determining validity index of the scores of twelve schemes of thought problems. Point biserial correlations give validity coefficient or other performance scores. The method is suitable when, scoring schemes are based on: 1, if correct response; and 0, if incorrect response. In the study, total scores obtained by the subjects in sixty eight thought processes were used, as the criterion, for calculating the validity coefficients. The following formula (3.2) was used :

$$r_{pbi} = \frac{M_i - M_T}{S_i} \sqrt{\frac{N_i N}{No(N-1)}} \quad .... \quad (3.2)$$

in which,

r_{pbi}	-	represents point biserial coefficient of items' validity;

M_1 - represents the mean of the group scoring 1s in the problems;

M_T - represents the mean of the entire group (or of the study sample);

N_1 - represents the number of the group passing items (with 1s);

N_0 - represents the number of the group failing items (with 0s)

$N=N_1+N_0$ - represents the total number of the entire group;

S_t - represents the standard deviation (S.D.) of total scores for the entire group.

The calculated validity coefficient of twelve schemes of thought problems are shown in Table 3.14.

<u>Table 3.14</u>

Showing Coefficients of Reliability and Validity of Twelve Schemes of Thought Problems

Problem Number	Scheme of thought	Kuder & Richardson reliability coefficient (N = 270)	Point Biserial Item Validity Index (N = 270)
Prob-1	Conservation of volume	.77	.73
Prob-2	Using common Differences	.69	.84
Prob-3	Combinatorial Analysis	.82	.87
Prob-4	Observation Perspective	.32	.16
Prob-5	Seriation	.38	.74
Prob-6	Classification	.73	.41
Prob-7	Proportionality	.53	.70
Prob-8	Stating Hypotheses	.57	.57

Problem Number	Scheme of thought	Kuder & Richardson reliability coefficient (N = 270)	Point Biserial Item Validity Index (N = 270)
Prob-9	Chance occurance and probability	.81	.31
Prob-10	Insightful figural knowledge	.75	.27
Prob-11	Grasping Essence of Problem	.63	.33
Prob-12	Generalized Logical Thought	.80	.36

3. Interpretation of the Reliability and Validity Coefficients

A test score is called reliable when there are reasons for believing the score to be stable and trust worthy. Reliability coefficients of tests show the reliability or consistency of test scores. Validity coefficients show the extent to which test scores are trustworthy. Reliability coefficients of observed test scores measure results of activities and performances. The measures are therefore liable to error effects. Such errors as: of observers; situation; and measuring instruments, do present limiting effects to observed test scores or performances. Measuring instrument errors are of paramount importance in test scores, more so when a limited number of items are selected out of a large pool of items. The results show effect of chance, errors that are inherent in the test itself, and are the only ones affecting reliability of test and performances. If test

items are not selected at random, there may be a consistent or systematic error pattern shown, in any particular set of items. Such consistent errors affect the validity of the tests, Kuder and Richardson (1937) formula employed in the calculation of reliability coefficients of the study's tests is suited, for measuring such internal inconsistencies, especially of the content sampling and content heterogeneity of the items (Anastasi: 1968).

Mathematical statisticians interpret results of obtained reliability coefficients, through the use of such formula as :

$$r_{11} = \frac{S_e^2}{S_1^2} \quad \ldots \quad \ldots \qquad (3.1a)$$

in which,

r_{11} - represents the reliability coefficientr of one individual test (problem);

S_e^2 - represents chance error variances of the test (problem);

S_1^2 - represents the variance of true scores of the test (problem)

It follows from formula (3.1a) that any departures from true variances and chance error variances will not be un-related to values of resultant reliability coefficients. Accordingly, the obtained reliability coefficients of the study, (See table 3.14) were interpreted, as the percentage of true variances, in relation to the chance error variances. As examples the obtained reliability coefficient values (in

table 3.14), given as: .77 (of Prob-1) or .32 (of Prob-4) signify that 77 percent (in the case of Prob-1) and 32 per cent (in the case of Prob-4), of variances in the problem scores depend, on true variances of traits measured; and 23 percent (of Prob-1) or 68 percent (of Prob-4) depend, on error variances. As such 10 schemes out of 12, of thought problems of the study have, high percent variances in traits measured, while two (Prob-4 and Prob-5) have low true variances. Hence the majority (10), of the reliability coefficients of the twelve schemes of thought problems were considered appropriate and reliable for the type of sample behaviour characteristics studied.

Test scores are valid when performances they measure, correspond to the same performances as, otherwise independently measured or objectively defined. For this, validity index or coefficient is a relative term and a test is valid for a particular purpose or in a particular situation. The choice of a validation procedure therefore depends on the use to be made of the test scores. Several researchers, Anastasi (1968) and others, prefer construct validity, as, appropriate measures for validation tests of logical reasoning. Construct validity of a test by definition, is a theoretical measure of constructs or traits. The validation requires a gradual accumulation of information from a variety of scores.

Tests like Stanford-Binet and DAT battery of tests are appropriately recommended measures of traits, abilities, differentiations and other. They report tested validity data. Their validity interpretations are therefore relevant to interpretation for the study tests or problems. Cognitive Abilities Test show concurrent validities, ranged from .50's to .70's and School & College Ability Tests (SCAT) norms show, validity correlations ranging between .60 and .80. These tests measure construct and concurrent validites, as well as, content validities. The obtained validity coefficients for the twelve schemes of thought problems (shown in table 3.14), were, therefore, interpreted in terms of those. Table 3.14 shows seven problems whose validity coefficients ranged from .50's to .90's are shown ranged from .20's to .40's and only one validity coefficient is shown in .10's. The high validity coefficients (in .50's to .90's) reveal the type of items used in the study, as being correlative to the total performances scores of the problems, as evidenced by point biserial (r_{pbi}) correlation method of calculation. Validity coefficients in the .20's to .40's were considered moderately high and appropriate; but .16 validity coefficient (of Prob-4) was interpreted as being poor and not suited to measure desired traits.

4. <u>Calculating the Difficulty Index</u>

Measures for the difficulty index (also referred to as, "Facility Value"), for each of the twelve schemes of

thought problems were obtained, using formula (3.3) as follows :

$$F.V. = \frac{N_{pi}}{N} \quad \ldots \quad \ldots \quad (3.3)$$

in which

F.V. - represents the difficulty index (or facility value) of each of the twelve schemes of thought problems;

N_{pi} - represents the number of those who passed (or answered) items correctly;

N - represents the entire group who attempted the problem

The calculated difficulty indices are shown in table 3.15.

5. <u>Calculating the Discrimination Index</u>

Method of difference of proportions of individuals answering items right with those answering items wrong was employed. As stated in formula (3.4) it is as follows :

$$D.I. = \frac{N_{pi}}{N} - \frac{N_{qi}}{N} \quad \ldots \quad \ldots \quad (3.4)$$

in which

D.I. - represents the discrimination index for the individual problems;

N_{pi}/N - represents the proportion of those passing correctly, items of the problems;

N_{qi}/N - represents the proportion of those not passing items of the problems correctly;

N - represents, as in formula 3.3;

pi - represents the proportion of those passing correctly the individual items of the problems;

q_i - (1-pi) represents the proportion of those not passing, correctly the individual items of the problems;

N_{pi} - represents, as in formula 3.3;

N_{qi} - represents the number of those not passing correctly items of the individual problems;

N - represents, as in formula 3.3;

Table 3.15 shows the calculated values of the discrimination indices.

Table 3.15

Showing the difficulty and Discrimination indices of the twelve schemes of thought problems

Problem Number	Scheme of Thought	Difficulty Index (Facility value)	Discrimination Index
Prob-1	Conservation of volume	.58	.16
Prob-2	Using Common Differences	.82	.50
Prob-3	Combinatorial Analysis	.83	.65
Prob-4	Observation: Perspective	.58	.16
Prob-5	Seriation	.61	.21
Prob-6	Classification	.46	-.08
Prob-7	Proportionality	.35	-.29
Prob-8	Stating Hypotheses	.53	.05
Prob-9	Chance occurrences and Probability	.70	.40
Prob-10	Insightful figural knowledge	.81	.62
Prob-11	Grasping Essence of Problem	.43	-.15
Prob-12	Generalized logical thought	.47	-.07

6. Interpretation of the Difficulty and Discrimination Indices

The difficulty of an item may be determined in several ways, including: (1) by judgement of competent people who rank the items in order of difficulty; (2) by how quickly the items can be solved; and (3) by the number of examinees in the group who get the items right. The last of these methods has been employed in determining the difficulty index of the study's problems. As items of the problems were of objective type tests, Morrison's Item Facility Value Formula was suitable for their calculation. By definition, Morrison's Facility Value (F.V.) measures easiness or difficulty of items. It is the mean percentage mark which a homogenous group of average ability subjects (M=50%) are expected to obtain. It was in the light of the Morrison's definition of Difficulty Index that Difficulty Index for the twelve problems, were calculated.

In the results, three of the problems (Prob-2, Prob-3 and Prob-10) showed index values of easiness; and one (Prob-7) showed an index of difficulty. The remaining eight problems showed appropriately high Discrimination Index measures of high ability and low ability students. But for discrimination index values, a value greater than +.20, among a sample numbering more than 200 indicates a satisfactory degree of discrimination. Values between 0.0 and .20 indicate, items which need improvement. Values with negative values need being discarded. Accordingly, five problems (Prob-2; Prob-3;

Prob-5; Prob-9; and Prob-11) showed discrimination indices, ranging between .20 and .70. Their items were described as satisfactory. Three problems, (Prob-1, Prob-4 and Prob-9) showed indices, ranging between 0.0 and .20. Their items needed improvement. The remaining four problems (Prob-6, Prob-7, Prob-11 and Prob-12) showed indices that qualified them, according to theoretical considerations, as being highly discardable.

Characteristics of Other Variables of the Study: Four Psychological Tests

Four standardized test instruments were used for the study. By definition, a standardized test is one which has been used, revised and used again, until its results are uniform under specified conditions. The four standardized tests administered, included: (1) Raven's Progressive Matrices Test; (2) Numerical Ability Test; (3) Abstract Reasoning Test; and (4) Verbal Reasoning Test. They were used to serve as a basis for information on the subjects' intellectual capabilities and abilities in numerical, abstract, and verbal reasoning.

The Progressive Matrices Test was developed by Raven (1938; 1947; 1951; and 1962). Requiring chiefly, the eduction of relations among abstract items, the test is regarded as the best available measure of Spearman's 'g' factor. It consists of 60 sets of designs as its items. The subject chooses a missing pattern from six given

alternatives. The items are grouped into five sets: A; B; C; D and E. Each set contains 12 items (or matrice sets of patterns). The items are characterised by their increasing difficulty. They have similar principles for obtaining the solutions. Sets A, B, C and D require accuracy of discrimination, while set E involves analogies, permutations, alternation of the patterns and sense of logicalness in relations. No time limits are given for administration.

Little information is available on the tests' reliability and validity, despite and rapid pace, research continued to take, in dealing with the use of the test. The seventh Mental Measurements Year Book lists nearly 400 studies which use the test as one or part of the researches instruments. Retest reliability in groups of older children and adults that were moderately homogenous in age varies approximately between .70 and .90 and correlations with verbal and performance tests of intelligence range between .40 and .75, tending to be higher with performance than with verbal tests (Morrow, 1973).

The other three tests: Numerical Ability; Abstract Reasoning; and Verbal Reasoning, belong to the Battery of Differential Aptitude Tests (DAT)*.

* DAT sub-tests published by: Bennet, G.K. (1951) & 1959); Seashore, H.G. and Wesman (1951 and 1968) and the Psychological Corporation of U.S.A., (1947 and 1968).

Numerical Ability Test was designed to predict future numerical ability. That is, ability with numerical relations, numerical facility and number conceptr. Abstract Reasoning Test was designed to predict future abstract reasoning. This is, ability to reason with non-verbal materials, objects and patterns of figural relations. Verbal Reasoning Test was designed to predict future verbal reasoning. That is, ability to identify word similarities and background information. Table 3.16 shows their admissible time limites and maximum number of items.

Table 3.16

Showing maximum number of items as well as admissible time limits of three Standardized Tests of the Study

S. No.	Name of sub-tests*	Maximum No. of items	Maximum Allowed Time
1.	Numerical Ability	40	30 minutes
2.	Abstract Reasoning	50	25 minutes
3.	Verbal Reasoning	50 (but often to be combined with other sub-tests)	30 minutes

* Some publishers (e.g. Manasayan, New Delhi), have prepared norm tables, in the form of percentile bands, for DAT battery of tests. The manuals report, specific and combined, percentiles, of raw scores of true abilities of testees. Norms for eight DAT battery of tests are available for grades 8 through 12, for each sex. (See Appendix C for norms of: Numerical Ability; Abstract Reasoning; and Verbal Reasoning Tests).

CHAPTER IV

RESULTS AND DISCUSSIONS OF DESCRIPTIVE DATA ANALYSIS

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RESULTS AND DISCUSSIONS OF DESCRIPTIVE DATA ANALYSIS

Introduction

Data analysis, in a research project aims at manipulating, summarising and displaying research data so as to make the data more comprehensible; uncover underlying structures and detect important departures from the structures. The work has been greatly aided by the increasing availability of electronic computers for calculation. The machines have made it possible to collect and organize large amount of data, thus presenting to the analyst, only the problem of sensible selection from an overbundance of data. A normal data analysis begins, not with assumptions or a statistical model but with an examination of the available data, which may be a rough overview, tackled by plotting graphs and tabulations. The dominant patterns shown are then described by a statistical model, at a stage of guessing assumptions, such as : normality, additivity of effects, independence of observations, etc., and detecting departures from assumptions

revealed through aids of graphs, tabulations and other displays.

Some procedures developed and commonly employed for data analysis include those of descriptive statistical methods, and statistical inference. The aims of descriptive statistics include summarization, and presentation of research data, and analysis, which aids to the goals of discovering structures and anomalies. Inferential statistics per contra provides, objective measures for interpretations based upon collected data and methods that permit for inferring latent observations of population, from a knowledge derived from a cross-section of the population. Pursuant of those aims and objectives, data obtained from performance scores on twelve schemes of thought problems, and four standardised tests were subjected to techniques of descriptive analysis. Raw data from Appendix B were used. Table 4.1 shows instructions on reading Appendix B.

Table 4.1

Showing Instructions on reading Appendix B

S.No.	Column Numbers	Name and Description of Variable	Recode
1.	1,2,3	Serial Number of Pupils	1*
2.	4	VAR 001 (Sex): Category	1*
3.	5	VAR 002 (Age): Category	1*
4.	6	VAR 003 (Grade): Category	1*
5.	7	VAR 004 (Type of School): Category	1*

Contd.

S. No.	Column Numbers	Name and Description of Variable	Recode
6.	8	VAR 005 (Father's Occupation): Category	1*
7.	9	VAR 006 (Mother's Occupation): Category	1*
8.	10,11	VAR 007 (RMT) : Scores	1*
9.	12,13	VAR 008 (AAT) : Scores	1*
10.	14,15	VAR 009 (ART) : Scores	1*
11.	16,17	VAR 010 (VRT) : Scores	1*
12.	18,19,20	VAR 011 (Psychological Tests): Total Scores	1*
13.	21	VAR 012 (Prob-1) : Scores	1*
14.	22	VAR 013 (Prob-2) : Scores	1*
15.	23	VAR 014 (Prob-3) : Scores	1*
16.	24	VAR 015 (Prob-4) : Scores	1*
17.	25	VAR 016 (Prob-5) : Scores	1*
18.	26	VAR 017 (Prob-6) : Scores	1*
19.	27	VAR 018 (Prob-7) : Scores	1*
20.	28	VAR 019 (Prob-8) : Scores	1*
21.	29	VAR 020 (Prob-9) : Scores	1*
22.	30	VAR 021 (Prob-10): Scores	1*
23.	31,32	VAR 022 (Prob-11): Scores	1*
24.	33	VAR 023 (Prob-12): Scores	1*
25.	34,35	VAR 024 (Problems): Total Scores	1*
26.	36,37	VAR 093 (Thought Processes): Total Scores	2**
27.	38,39,40	Serial Number of Pupils	1*

* Showing codings, on Computer Sheet, Card No.1
** Showing coding, on Computer Sheet, Card No.2

Results of Descriptive Statistical Analysis on Four Psychological Tests

Original scores of sampled subjects in four standardised tests are shown in Appendix B (Columns : 10-17); and values of their computerised means, medians, mode and standard deviations are shown in table 4.2.

Table 4.2

Showing Mean, Median, Mode and Standard Deviation, Values of Four Psychological Tests

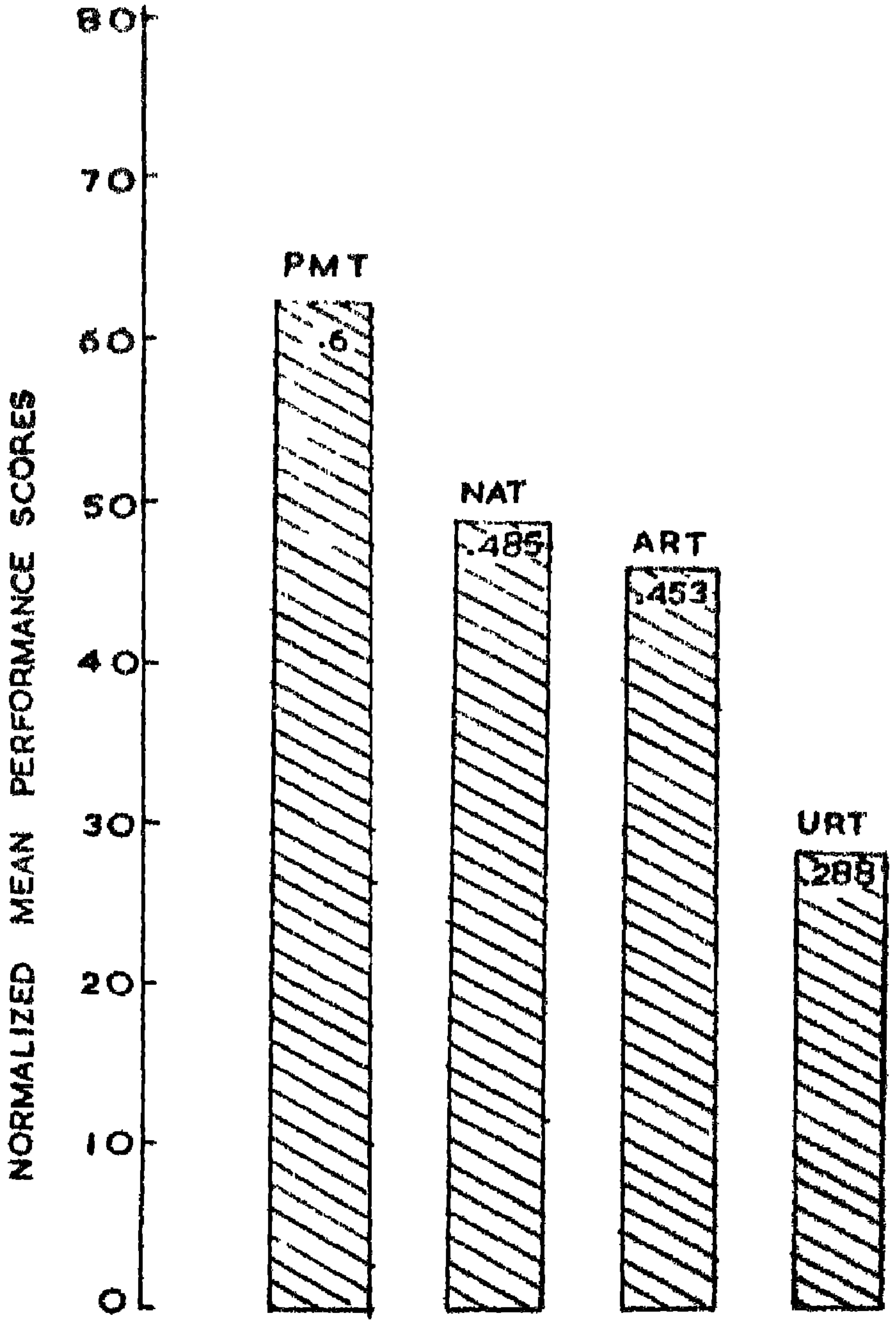
Name of Test	No. of Cases	Mean	Median	Mode	S.D.
PAT	270	37.530	39.658	40.000	10.057
MAT	270	19.385	17.962	15.000	6.424
AHT	270	22.959	23.083	20.000	7.048
VAT	270	14.404	14.500	12.000	4.228
Total		94.167	94.167	89.000	21.180

The statistical values (of table 4.2) showed high correlation with counterpart statistics of DAT sub-tests (of Appendix C), sexwise, agewise, as well as, gradewise.

Figure 4.1 shows the diagramatic representations of levels of their mean performance scores. Indicating the best performance achievement in intelligence test, and the least, in language ability test.

FIGURE 4.1

SHOWING LEVELS OF MEAN PERFORMANCE SCORES ON FOUR PSYCHOLOGICAL TESTS



BAR GRAPHS OF: PMT, NAT, ART & VRT

(N = 270)

Mean Values of Four Psychological Tests

Separate mean performance values were obtained on four psychological tests (as shown in tables 4.3 through to table 4.8).

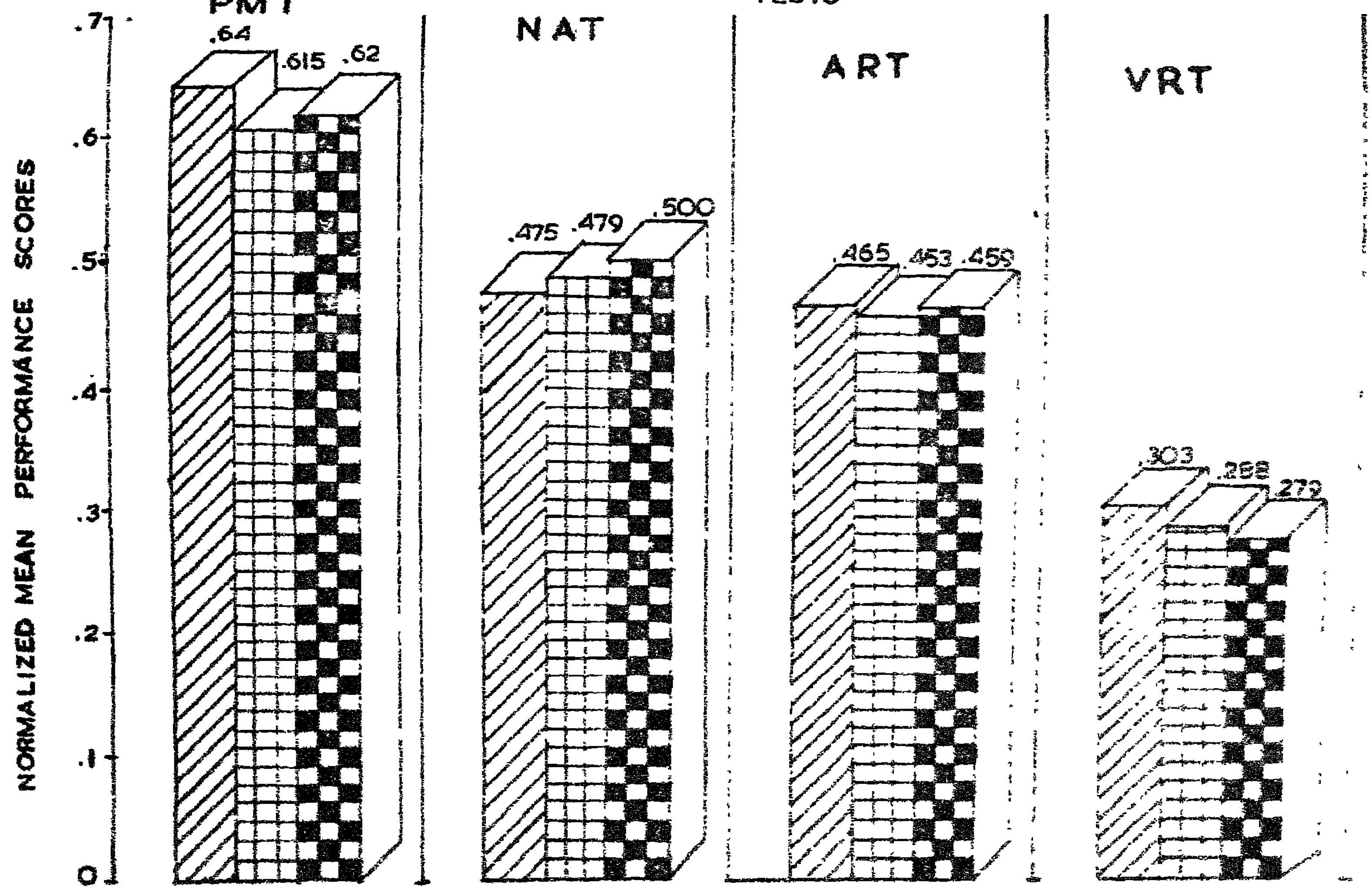
Table 4.3

Showing Sexwise Mean Performance Scores of Four Psychological Tests

S. No.	Sex	Four Psychological Tests					
		No.	PMT Mean	NAT Mean	ART Mean	VRT Mean	Total Mean
1.	Females	87	33.93	15.47	20.40	13.77	83.76
2.	Males	183	39.24	21.25	24.16	14.71	99.12
	Total	270	37.53	19.39	22.95	14.40	94.17

According to table 4.3 (above) mean performance scores are shown higher on all four psychological tests in favour of males. Agewise (shown in table 4.4), mean performance scores on Numerical Ability Test, increased with ages. But mean performance scores on Verbal Reasoning Test decreased with increase in age. Younger age group (of 13-14 years) showed the highest mean performance scores on Raven's Progressive Matrices Test, as well as, on Abstract Reasoning Test. Figure 4.2 shows the diagramatic representation of agewise scores on the four psychological Tests.

SHOWING AGEWISE LEVELS OF PERFORMANCE ACHIEVEMENTS ON FOUR PSYCHOLOGICAL TESTS



MULTIPLE BAR CHARTS OF MEAN PERFORMANCE SCORES ON PSYCHOLOGICAL TESTS OF PMT, NAT, ART, & VRT. (N= 270)

AGE GROUP (OF 13-14 YEARS) AGE GROUP (OF 14-15 YEARS) AGE GROUP (OF 15-16 YEARS)

Table 4.4

Showing Agewise Mean Performance scores on Four Psychological Tests

S. No.	Age Groups (in years)	No. of cases	PMT Mean	NAT Mean	ART Mean	VRT Mean	Total
1.	(13-14)	90	38.51	19.01	23.23	15.13	96.17
2.	(14-15)	90	36.88	19.16	22.67	14.10	92.77
3.	(15-16 or more)	90	37.20	19.99	22.98	13.98	93.57
	Total	270	37.53	17.96	22.96	14.40	94.17

Table 4.5

Showing Gradewise Mean Performance Scores of Four Psychological Tests

S. No.	Grade Groups	No. of cases	PMT Mean	NAT Mean	ART Mean	VRT Mean	Total
1.	F7	78	30.77	14.00	21.62	13.31	79.19
2.	S1	96	37.78	18.08	20.68	14.28	90.65
3.	S2	96	41.09	21.96	23.56	15.37	102.27
	Total	270	37.53	19.39	22.96	14.40	94.17

Gradewise, mean performance scores on tests of Progressive Matrices, Numerical Ability, and Verbal Reasoning are shown increased with grades (in table 4.5). The middle grade group (of senior one) is shown, obtaining the least mean performance scores on Abstract Reasoning Test. Figure 4.3 shows the diagrammatic representation of the performance scores.

On studying the mean scores on four Psychological Tests by age, and sex groups, females of younger age (of 13-14 years) showed, better scores (as seen in table 4.6).

Older age, females (of 15-16 or more years) trailed behind. The same trend of mean scores is shown in performance scores of the age groups of males. Older age group (of 15-16 or more years) are shown topping in performance scores of Numerical Ability Test. Figure 4.4 shows the diagrammatic representation of the levels of the scores.

Table 4.6

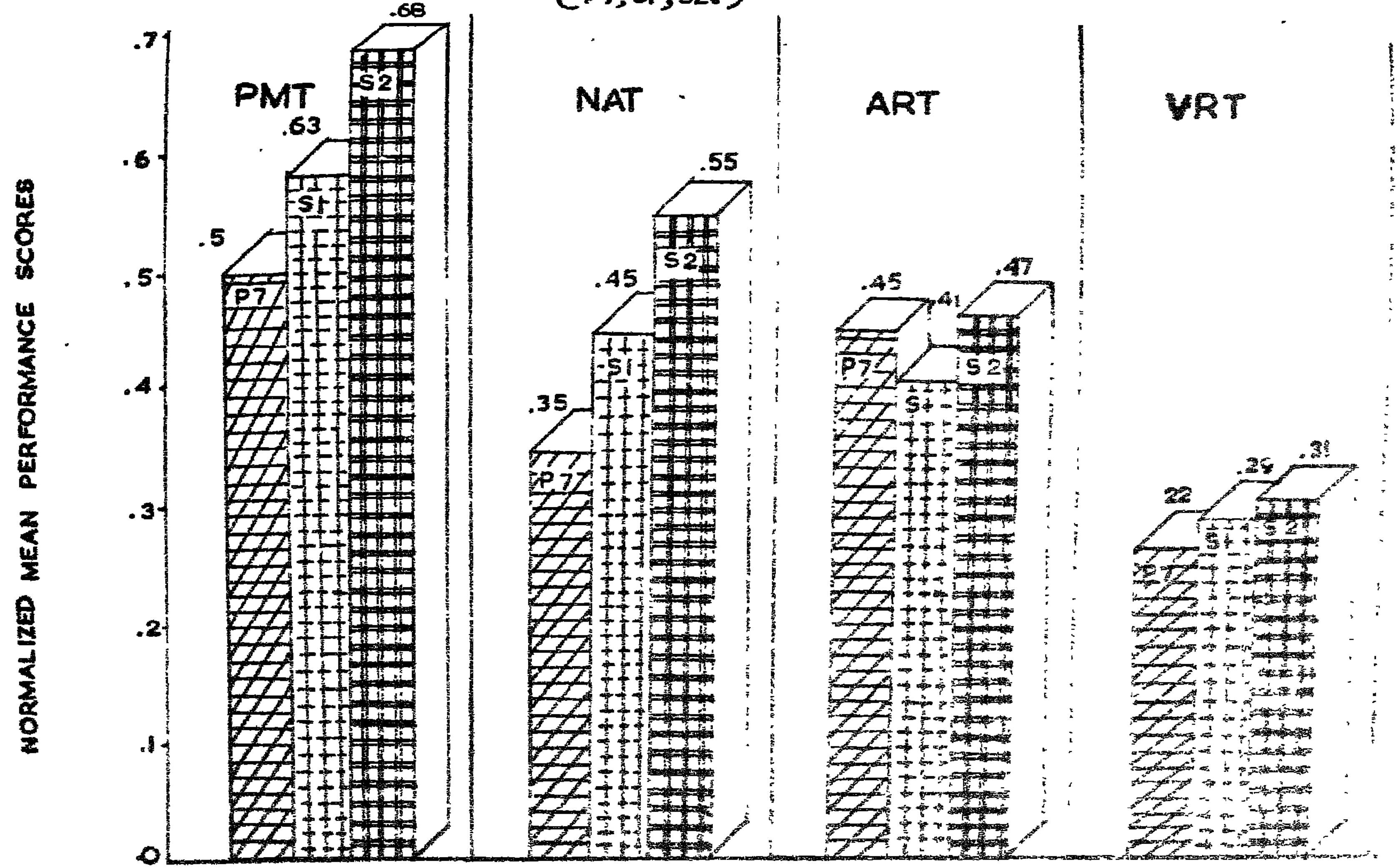
Showing Sex and Agewise Mean Performance Scores of Four Psychological Tests

A. Females (Agewise)

S. No.	Age groups (in years)	No. of cases	PMT Mean	NAT Mean	ART Mean	VRT Mean	Total Mean
1.	(13-14)	29	34.31	15.83	20.97	14.52	85.55
2.	(14-15)	29	33.76	15.45	20.28	13.07	82.21
3.	(14-16 or more)	29	33.72	15.14	19.97	13.72	83.52
	Total	87	33.93	15.47	20.40	13.77	83.76

FIGURE 4.3

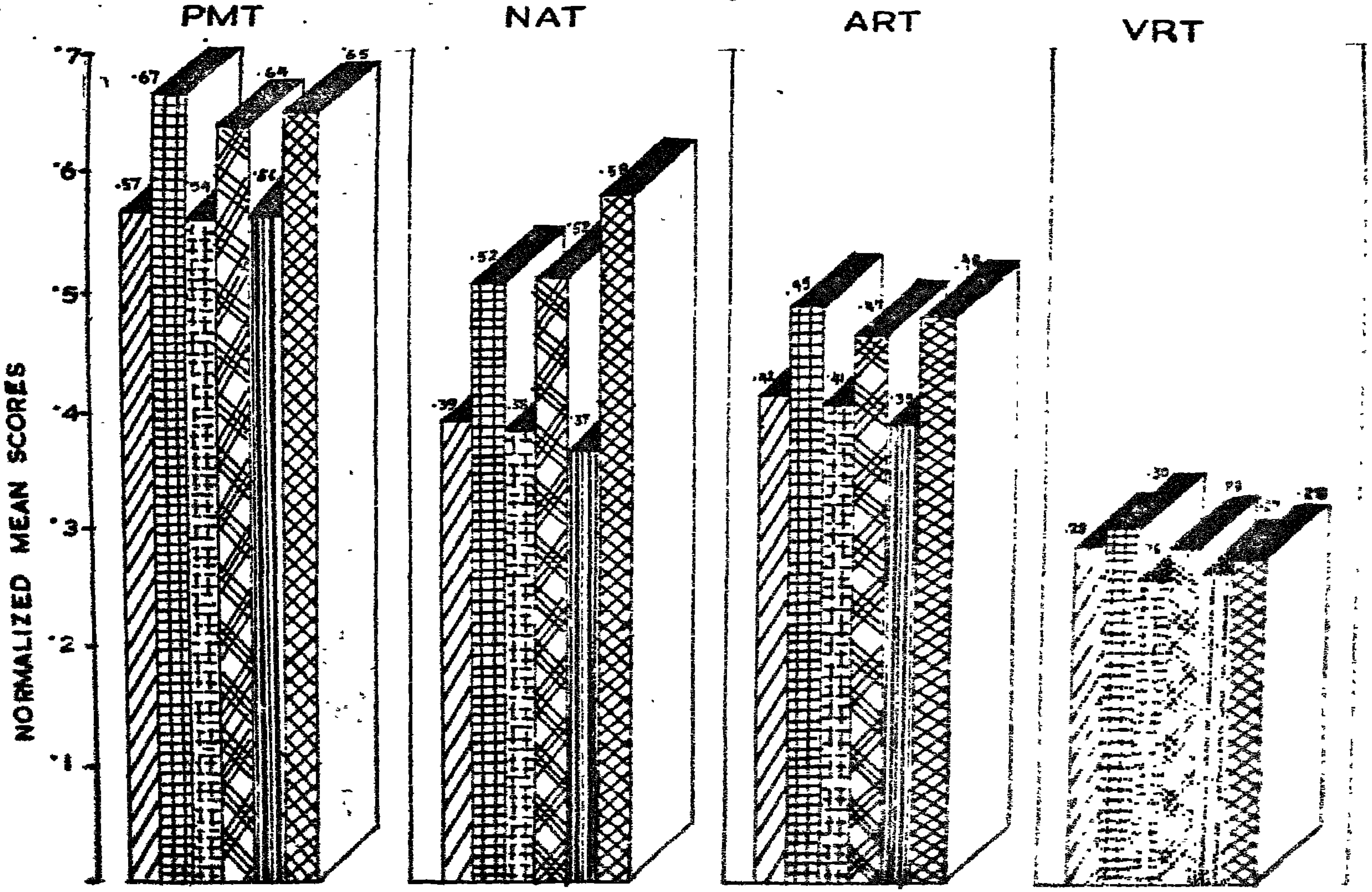
SHOWING LEVELS OF PERFORMANCE IN FOUR PSYCHOLOGICAL TESTS BY THREE GRADE GROUPS (P7, S1, S2.)



MULTIPLE BAR CHARTS OF MEAN PERFORMANCE SCORES ON PSYCHOLOGICAL TESTS OF PMT, NAT, ART, VRT. (N=270)

GRADE GROUP (OF P7) GRADE GROUP (OF SENIOR ONE) GRADE GROUP (OF SENIOR TWO)

SHOWING SEX – AGEWISE LEVELS OF MEAN PERFORMANCE SCORES ON FOUR PSYCHOLOGICAL TESTS



BAR CHARTS OF MEAN PERFORMANCE SCORES ON PMT NAT ART & VRT (N=270)

FEMALES AGED (13-14) YRS. MALES AGED (13-14) YRS FEMALES AGED (14-15) YRS.

MALES AGED (14-15) YRS. FEMALES AGED (15-16) YRS. MALES AGED (15-16) YRS.

B. **Males** (Agewise)

1.	(13-14)	61	40.50	20.58	24.40	15.39	101.31
2.	(14-15)	61	38.33	20.87	23.70	14.62	97.63
3.	(15-16 or more)	61	38.85	22.30	24.41	14.10	98.34
	Total	183	39.24	21.25	24.16	14.71	99.12

On studying mean performance scores of grade groups, sexwise (as seen in table 4.7), mean performance scores on PMT, and MAT are shown increased with grades of both sexes. Females in the middle grade are seen performed the lowest on ART; and fairly constant performance scores of males are shown on VRT. Figure 4.5 shows the diagramatic representation of the levels of the scores.

Table 4.7

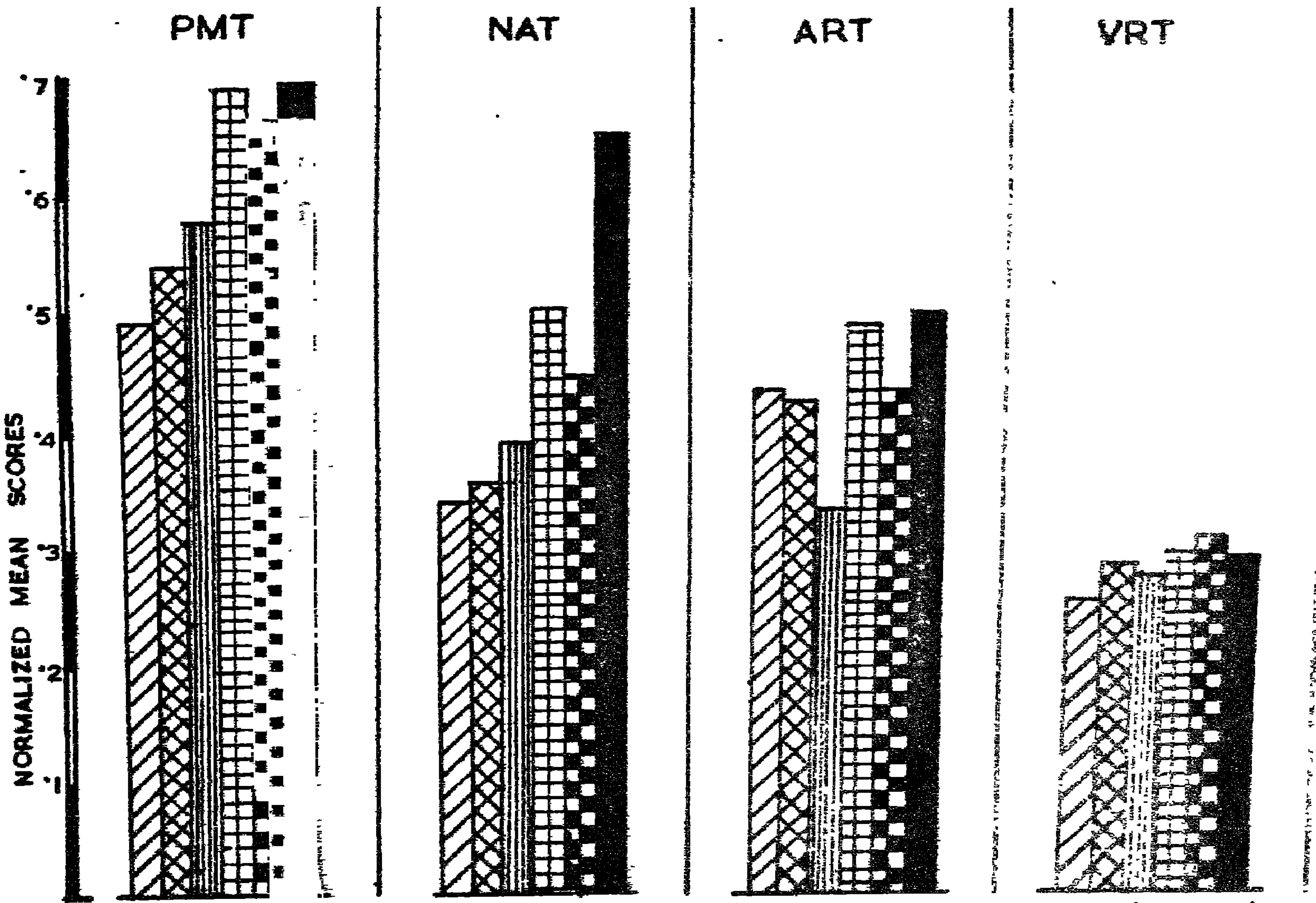
Showing Sex and Gradewise Mean Performance scores for Four Psychological Tests

A. **Females** (Gradewise)

S. No.		N	Psychological Tests PMT Mean	MAT Mean	ART Mean	VRT Mean	Total Mean
1.	P7	39	29.23	13.80	21.72	12.54	77.54
2.	B1	24	34.71	15.79	16.75	13.71	80.83
3.	B2	24	40.79	17.88	21.92	15.83	96.76

B. **Males** (Gradewise)

1.	P7	39	32.71	14.21	21.51	14.08	80.85
2.	B1	72	40.85	20.36	24.60	14.84	100.47
3.	B2	72	41.39	26.03	25.20	14.90	107.76
	Total	183	39.24	21.25	24.16	14.71	99.12



BAR CHARTS OF MEAN PERFORMANCE SCORES ON PMT, NAT, ART, VRT, (N= 270)

FEMALES OF P7

MALES OF P7

FEMALES OF SENIOR ONE

MALES OF SENIOR ONE

MALES OF SENIOR TWO

FEMALES OF SENIOR TWO

Mean performance scores of subjects whose parents were both peasants and housewives showed more in aggregate scores (as shown in table 4.8). Mean performance scores of subjects of professionals, doctors, accountants, teachers, managers etc., as well as, of "others", showed better mean performance scores in Raven's Progressive Matrics Test. Verbal Reasoning Test is seen poorly performed by children of peasant fathers.

Table 4.8

Showing Mean Performance Scores on Four Psychological Tests with Respect to Parental Occupations

A. Father's Occupation

S. No.	Occupation	N	%	PMT Mean	NAT Mean	AST Mean	VRT Mean	Total Mean
1.	Peasants	167	61.9	37.24	20.07	23.04	14.02	98.82
2.	Teachers, Professionals & Managerials	87	32.2	38.30	18.43	22.52	15.18	95.17
3.	Others	16	5.9	36.38	17.49	24.50	14.19	92.31

B. Mother's Occupation

S. No.	Occupation	N	%	PMT Mean	NAT Mean	AST Mean	VRT Mean	Total Mean
1.	Housewives	244	90.0	37.46	19.59	23.05	14.44	94.32
2.	Teachers Professionals & Managerials	17	63.0	38.12	16.82	22.41	14.29	92.94
3.	Others	9	3.3	38.33	18.67	21.67	13.67	92.33
	Total	270	100.0	37.53	19.39	22.96	14.40	94.17

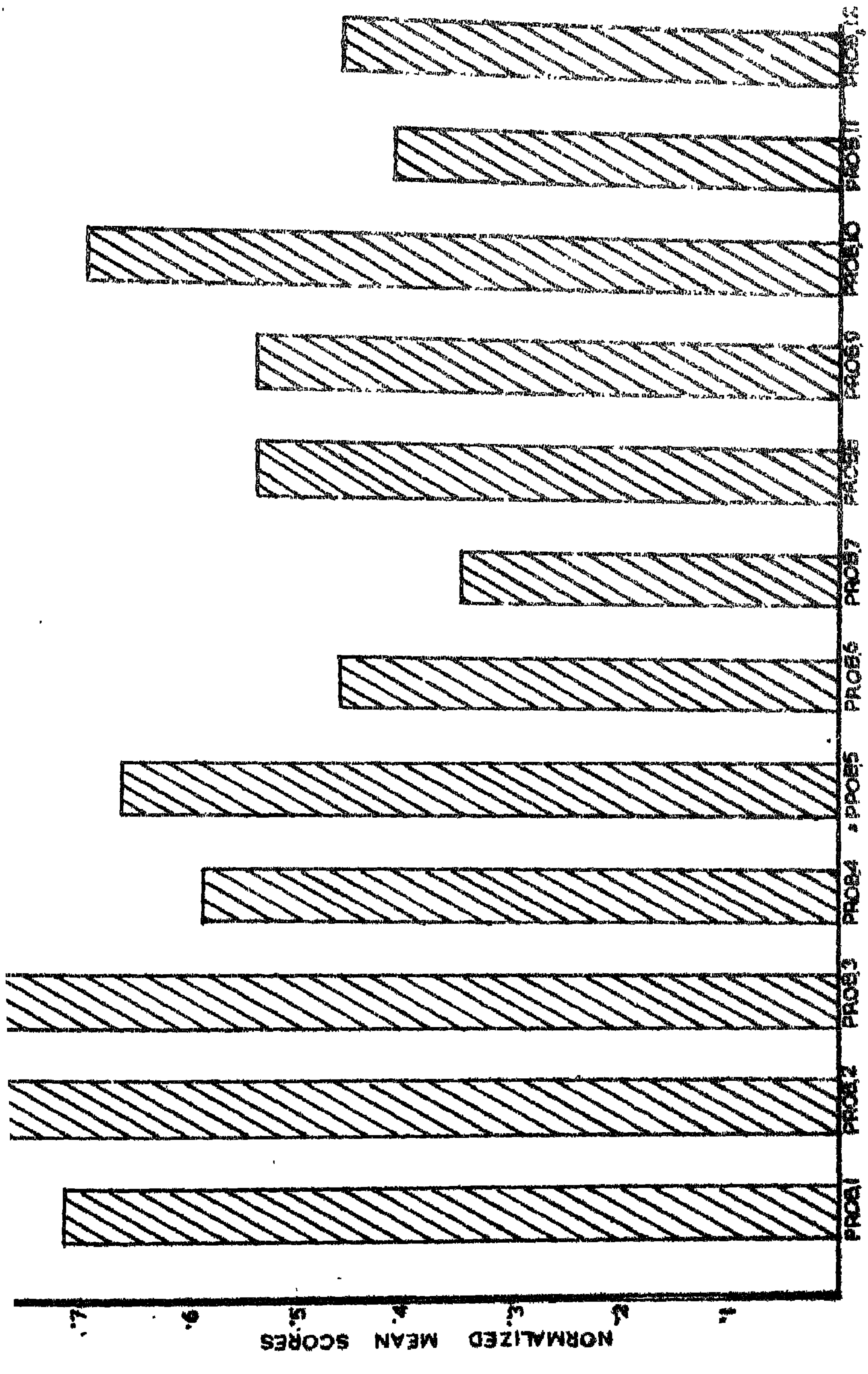
Results of the Descriptive Statistical Analysis on Twelve Schemes of Thought Problems

Original scores of sampled subjects on twelve schemes of thought problems are shown in Appendix B (columns 21-33). The mean performance scores are shown in table 4.9, along with the median, mode and standard deviation scores. Figure 4.6 shows their mean performance levels represented diagramatically. Four problems stand out, as the best of all performed.

Table 4.9

Showing Number of Cases, Mean, Median, Mode and Standard Deviation Values of Twelve Schemes of Thought Problems

Problem Number	N	Mean	Median	Mode	S.D.
Prob-1	270	6.463	6.250	5.000	1.563
Prob-2	270	4.096	0.0	5.000	1.127
Prob-3	270	3.304	0.0	4.000	1.218
Prob-4	270	1.737	1.806	2.000	0.663
Prob-5	270	3.030	3.013	3.000	1.020
Prob-6	270	2.307	2.073	2.000	1.371
Prob-7	270	1.059	0.990	1.000	0.793
Prob-8	270	3.159	3.098	3.000	0.980
Prob-9	270	4.270	4.078	4.000	1.175
Prob-10	270	4.867	5.460	6.000	1.562
Prob-11	270	4.237	4.156	5.000	1.931
Prob-12	270	4.222	3.625	3.000	1.740
Total		42.600	42.333	44.000	8.065



BAR GRAPH OF TWELVE PROBLEMS

Various Mean Values obtained on Twelve Schemes of Thought Problems

Separate mean values on twelve schemes of thought problems were obtained: agewise, as well as, gradewise. Tables 4.10 through to 4.14 show the various mean values.

Table 4.10 shows more higher mean performance scores obtained by males; and figure 4.7 shows the diagrammatic representation of the various levels of the performance, sexwise. Performance scores on Problems: 2, 3, 10 and 1 are the best of all obtained.

Table 4.10

Showing Sexwise Mean Performance Scores on Twelve Schemes of Thought Problems

Problem Number	A. Females (N = 87)		B. Males (N = 183)		Total (N = 270)	
	N	Mean	N	Mean	N	Mean
Prob-1	87	6.08	183	6.65	270	6.46
Prob-2	87	4.05	183	4.12	270	4.10
Prob-3	87	3.18	183	3.36	270	3.30
Prob-4	87	1.68	183	1.77	270	1.74
Prob-5	87	2.90	183	3.10	270	3.03
Prob-6	87	1.59	183	2.65	270	2.31
Prob-7	87	0.90	183	1.14	270	1.06
Prob-8	87	2.77	183	3.34	270	3.16
Prob-9	87	3.94	183	4.43	270	4.27
Prob-10	87	4.70	183	4.95	270	4.87
Prob-11	87	3.48	183	4.60	270	4.24
Prob-12	87	3.94	183	4.36	270	4.22
Total	87	39.10	183	44.27	270	42.60

FIGURE 4.7

SHOWING MEAN PERFORMANCE LEVELS OF FEMALES & MALES ON TWELVE PROBLEMS.

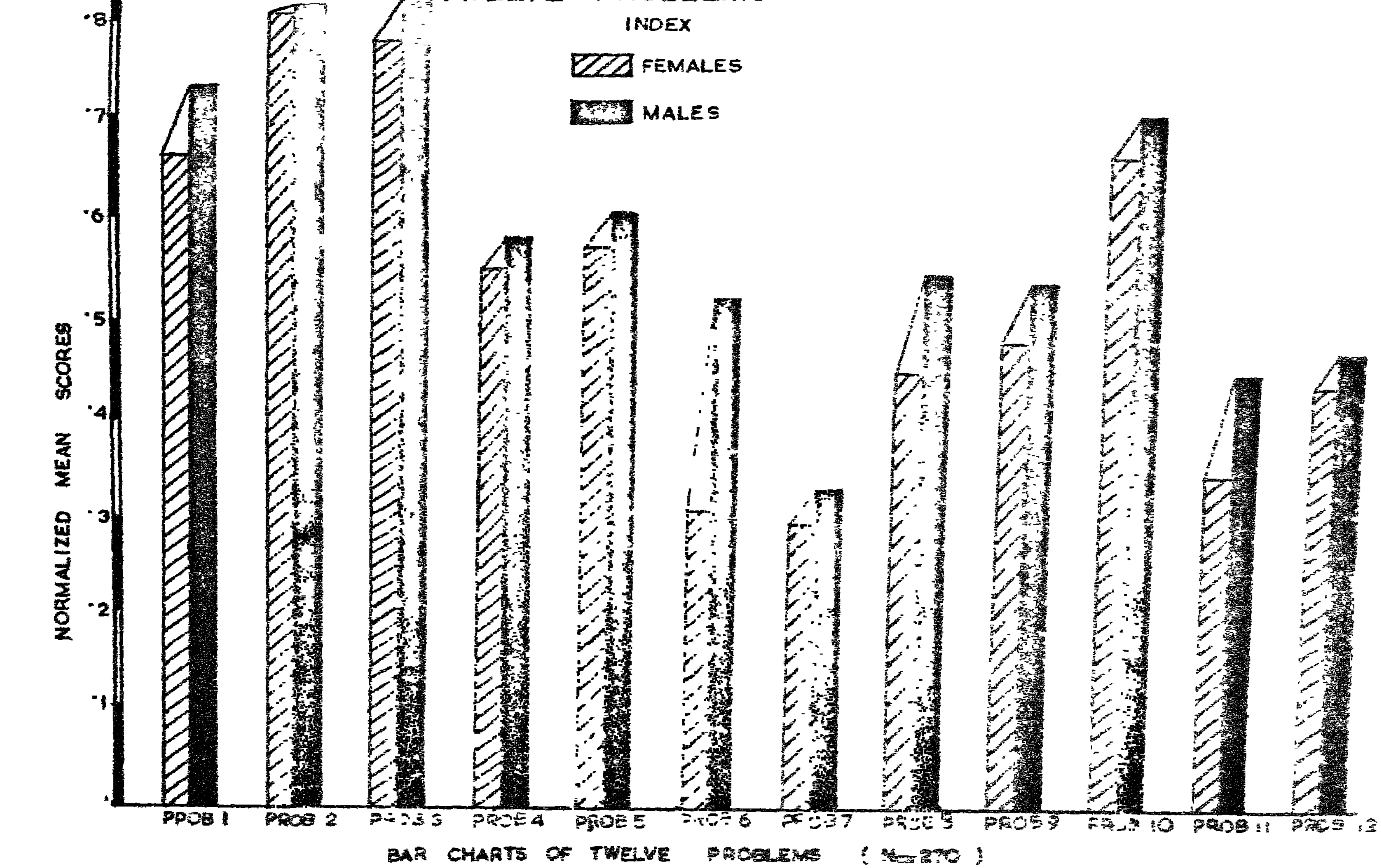


Table 4.11

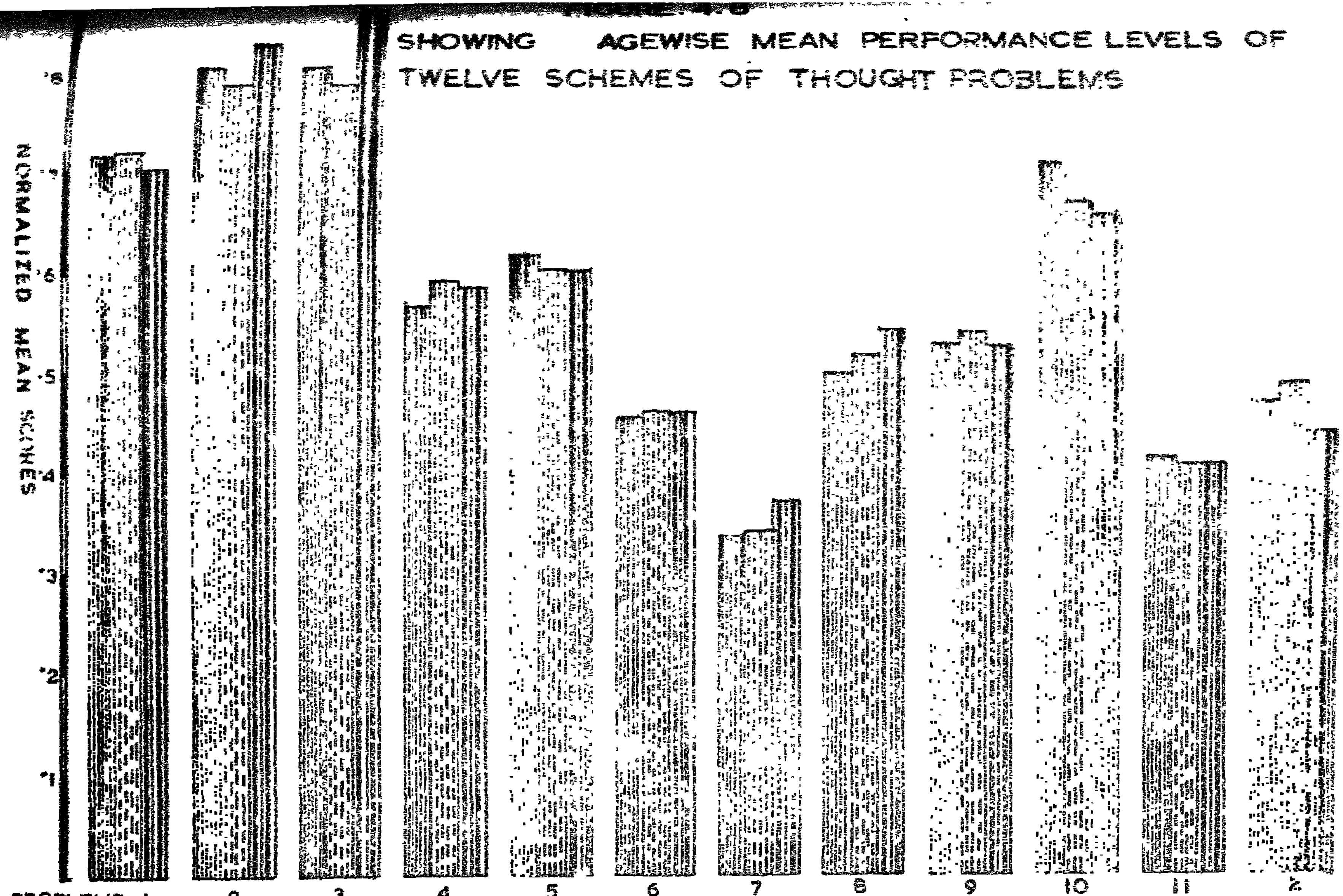
Showing Agewise Mean Performance Scores on Twelve Schemes of Thought Problems

Problem Number	N	Age Groups (in years) (13-14) Mean	(14-15) Mean	(15-16) Mean	Total
Prob-1	90	6.49	6.53	6.37	6.46
Prob-2	90	4.09	3.99	4.21	4.10
Prob-3	90	3.22	3.12	3.57	3.30
Prob-4	90	1.68	1.78	1.76	1.74
Prob-5	90	3.08	3.01	3.00	3.03
Prob-6	90	2.27	2.31	2.34	2.31
Prob-7	90	1.00	1.04	1.13	1.06
Prob-8	90	3.07	3.12	3.29	3.16
Prob-9	90	4.26	4.33	4.22	4.27
Prob-10	90	4.97	4.71	4.92	4.87
Prob-11	90	4.24	4.23	4.23	4.23
Prob-12	90	4.29	4.34	4.03	4.22

According to table 4.11, insignificant values of mean performance scores are shown, existed agewise. Older age group (of 15-16, or more years) are shown with more highest mean performance scores, in number (five), followed by the highest number of scores (four) of middle age group (of 14-15 years). Indicating that, agewise, the sampled subjects functioned at only two logical operation levels. Figure 4.8 shows the diagramatic representation of the various levels of mean performance scores.

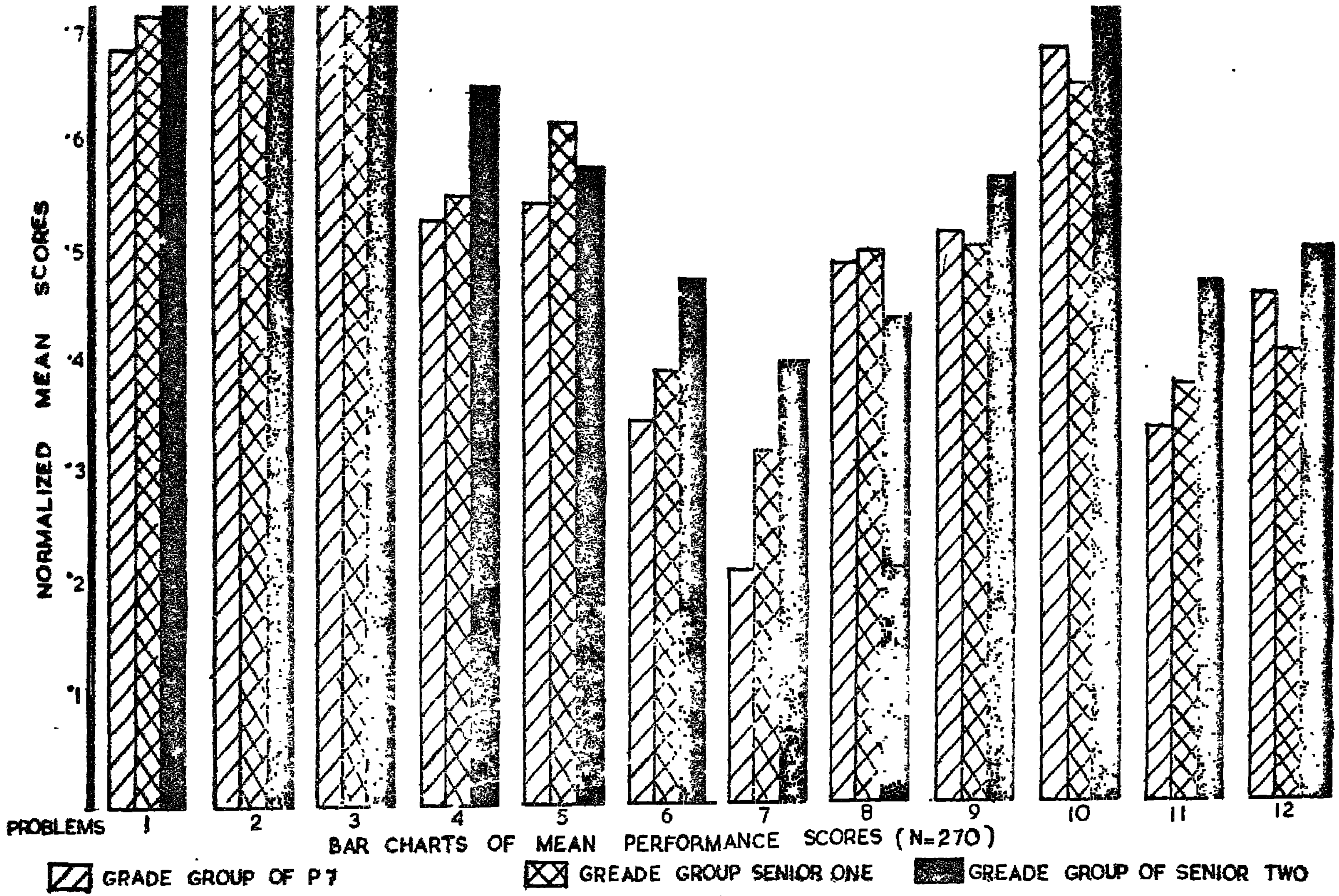
Results of gradewise performance scores on twelve schemes of thought problems (as seen in table 4.12) indicate marked differences existing between mean performance scores

SHOWING AGEWISE MEAN PERFORMANCE LEVELS OF TWELVE SCHEMES OF THOUGHT PROBLEMS



BAR CHARTS OF MEAN PERFOMANCE SCORES (N=270)

AGE GROUP (13-14) YRS. AGE GROUP (14-15) YRS. AGE GROUP (15-16 OR MORE) YRS.



BAR CHARTS OF MEAN PERFORMANCE SCORES (N=270)

of the three grade groups. The scores increased with grades on nearly all problems except problems 5 & 12. Figure 4.9 shows the diagramatic representation of the various levels of the scores.

When female and male mean performance scores were studied agewise (as seen in table 4.13) female and male mean performance scores of middle age of (14-15 years) showed the highest number by five problems, followed by the mean performance scores of younger age (of 13-14 years). The detailed performance scores agewise are shown diagramatically in Figure 4.10 indicating the positive relationships between sex, age, and performance scores.

Table 4.12

Showing Gradewise Mean Performance Scores on Twelve Schemes of Thought Problems

Problem Number	(N=78) F7 Mean	(N=96) S1 Mean	(N=96) S2 Mean	(N=270) Total Mean
Prob-1	6.08	6.34	6.70	6.46
Prob-2	3.80	4.12	4.22	4.10
Prob-3	3.04	3.12	3.61	3.30
Prob-4	1.56	1.63	1.94	1.74
Prob-5	2.65	3.03	2.83	3.03
Prob-6	1.72	1.94	2.61	2.31
Prob-7	0.86	0.93	1.17	1.06
Prob-8	2.87	2.91	3.25	3.16
Prob-9	4.04	3.98	4.46	4.27
Prob-10	4.72	4.46	5.12	4.87
Prob-11	3.42	3.76	4.70	4.24
Prob-12	4.13	3.72	4.50	4.22
Total	38.90	39.84	45.28	42.60

Table 4.13

Showing Sex and Agewise Mean Performance Scores on Twelve Schemes of Thought Problems

Problem Number	A. Females (Agewise) Age Groups (in years)				B. Males (Agewise) Age Groups (in years)			
	N	(13-14) Mean	(14-15) Mean	(15-16 or more) Mean	N	(13-14) Mean	(14-15) Mean	(15-16 or more) Mean
Prob-1	29	6.069	6.138	6.034	61	6.710	6.700	6.525
Prob-2	29	3.862	4.069	4.207	61	4.194	3.950	4.213
Prob-3	29	3.138	3.103	3.310	61	3.274	3.117	3.689
Prob-4	29	1.552	1.828	1.655	61	1.726	1.767	1.803
Prob-5	29	3.069	2.828	2.793	61	3.097	3.083	3.098
Prob-6	29	1.655	1.483	1.621	61	2.581	2.683	2.689
Prob-7	29	0.828	0.759	1.103	61	1.065	1.200	1.148
Prob-8	29	2.690	2.862	2.759	61	3.246	3.250	3.541
Prob-9	29	3.931	3.931	3.966	61	4.403	4.533	4.344
Prob-10	29	4.828	5.069	4.207	61	5.016	4.550	5.262
Prob-11	29	3.655	3.517	3.276	61	4.536	4.567	4.689
Prob-12	29	3.862	4.000	3.966	61	4.468	4.533	4.066
Total	29	39.138	39.310	38.828	61	44.306	43.733	44.754

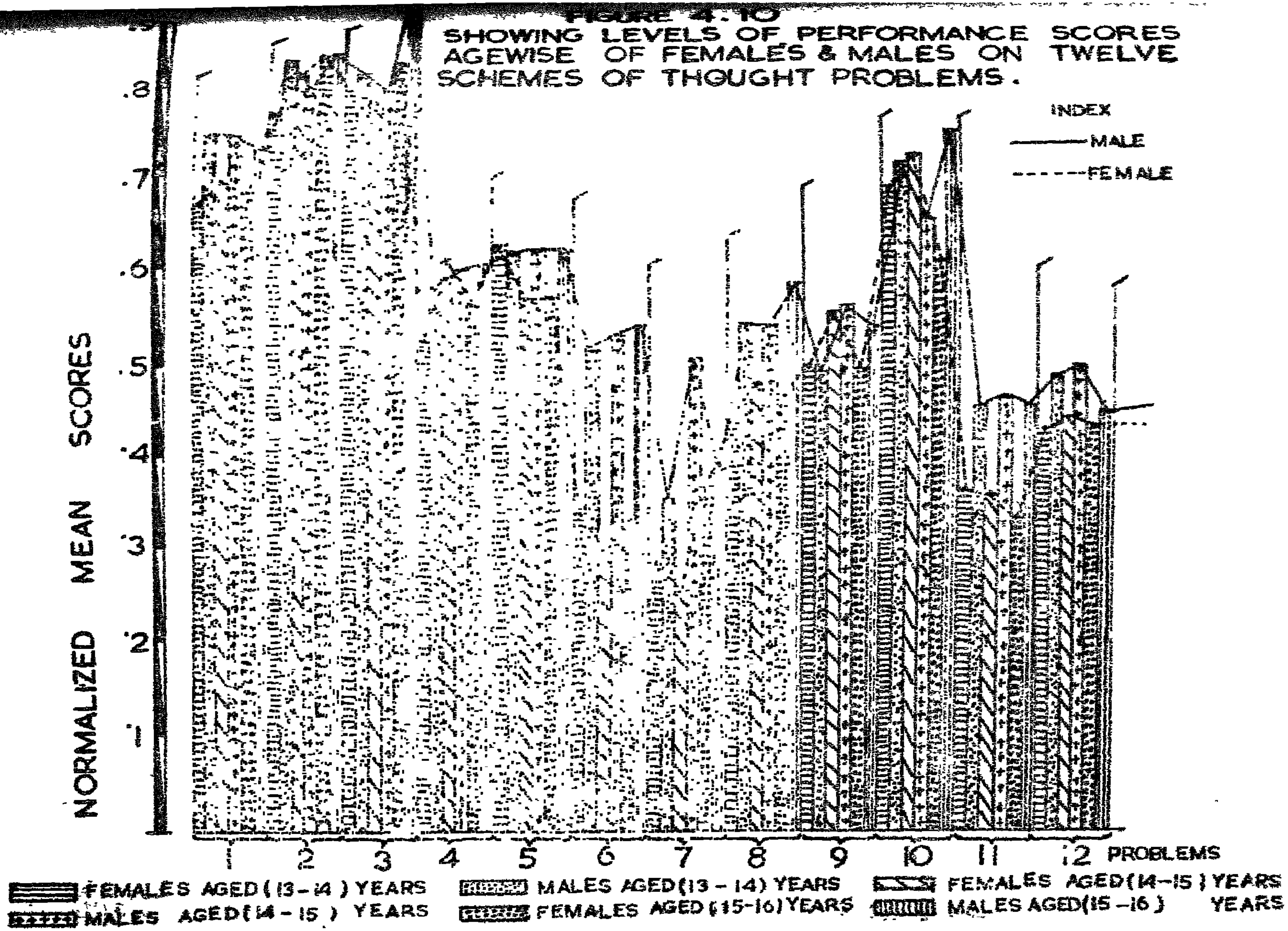


FIGURE 4.10
SHOWING LEVELS OF PERFORMANCE SCORES AGEWISE OF FEMALES & MALES ON TWELVE SCHEMES OF THOUGHT PROBLEMS.

but when grade groups were studied sexwise (using table 4.14) Mean performance scores of females of the higher grade (of S2) showed the highest number of top scores, followed by the ones of females of the lower grade, (of P7). Females of the middle grade (of S1) showed more lowest, mean performance scores. In the case of males, more mean performance scores increased with grade. Figure 4.9 also shows the diagramatic representation of the various performance scores presented in table 4.14.

Table 4.14

Showing Sex and Gradewise Mean Performance Scores on Twelve Schemes of Thought Problems

Sex	A. Females (Gradewise)			A. Males (Gradewise)		
Problem Numbers	P7 (N=39) Mean	S1 (N=24) Mean	S2 (N=24) Mean	P7 (N=39) Mean	S1 (N=72) Mean	S2 (N=72) Mean
Prob-1	5.80	6.29	6.33	6.36	6.40	7.06
Prob-2	4.00	4.00	4.17	3.59	4.25	4.28
Prob-3	3.08	2.79	3.75	3.00	3.44	3.48
Prob-4	2.62	1.50	1.96	1.51	1.75	1.92
Prob-5	2.56	3.04	3.29	2.74	3.01	2.37
Prob-6	1.41	1.29	2.17	2.03	2.59	3.05
Prob-7	0.95	0.75	0.96	0.77	1.10	1.38
Prob-8	2.87	2.42	2.96	2.87	3.40	3.55
Prob-9	3.95	3.79	4.08	4.13	4.18	4.85
Prob-10	4.92	4.04	5.00	4.51	4.88	5.25
Prob-11	3.41	2.96	4.13	3.44	4.56	5.27
Prob-12	4.13	3.71	3.88	4.13	3.73	5.13
Total	38.69	36.58	42.25	39.10	43.10	48.31

Mean performance scores on twelve schemes of thought problems studied, under categories of father's occupations and mother's occupations (using table 4.15) showed differing patterns of mean performance scores. Subjects whose fathers were peasants showed more of the highest mean scores followed by scores of subjects whose fathers were either professionals or managerials. Subjects of "others" parents showed more lowest mean scores. At the levels of mothers' occupations, subjects of "others" showed more of higher mean scores, followed by subjects of housewives. But studied at two categories of, parental occupations (using table 4.16) reveals subjects of "peasants and housewives" parents obtained more of higher mean scores. Subjects of "others" showed better performance on, such schemes as, Conservation of Volume, and Seriation. The two groups were shown nearly equal in mean scores of schemes of Combinatorial Analysis, Classification, Proportionality, and Generalised Logical Thought. Figure 4.11 shows the diagramatic representation of the levels of the various mean scores.

Contd.

Table 4.15

Showing Mean Performance Scores with Respect to Parental Occupations, on Twelve Schemes of Thought Problems

Problem Number	A. Father's Occupation			B. Mother's Occupation		
	(N=167) Peasants	(N=87) Professionals & Managerials	(N=16) Others	(N=244) House-wives	(N=17) Professionals & Managerials	(N=9) Others
	Mean	Mean	Mean	Mean	Mean	Mean
Prob-1	6.38	6.67	6.25	6.43	6.35	7.56
Prob-2	4.13	4.00	4.31	4.11	4.11	3.67
Prob-3	3.34	3.25	3.25	3.30	3.29	3.44
Prob-4	1.82	1.60	1.63	1.72	1.53	1.56
Prob-5	2.98	3.16	2.81	3.01	3.38	3.33
Prob-6	2.32	2.36	1.88	2.28	2.65	2.56
Prob-7	1.06	1.15	0.56	1.05	1.06	1.22
Prob-8	3.25	3.03	2.94	3.18	3.06	2.78
Prob-9	4.35	4.18	3.94	4.25	4.18	5.00
Prob-10	4.95	4.72	4.75	4.84	5.53	4.33
Prob-11	4.37	4.00	4.19	4.21	4.24	5.11
Prob-12	4.23	4.23	4.06	4.22	3.94	4.89
Total	43.01	42.05	40.56	42.52	42.24	43.44

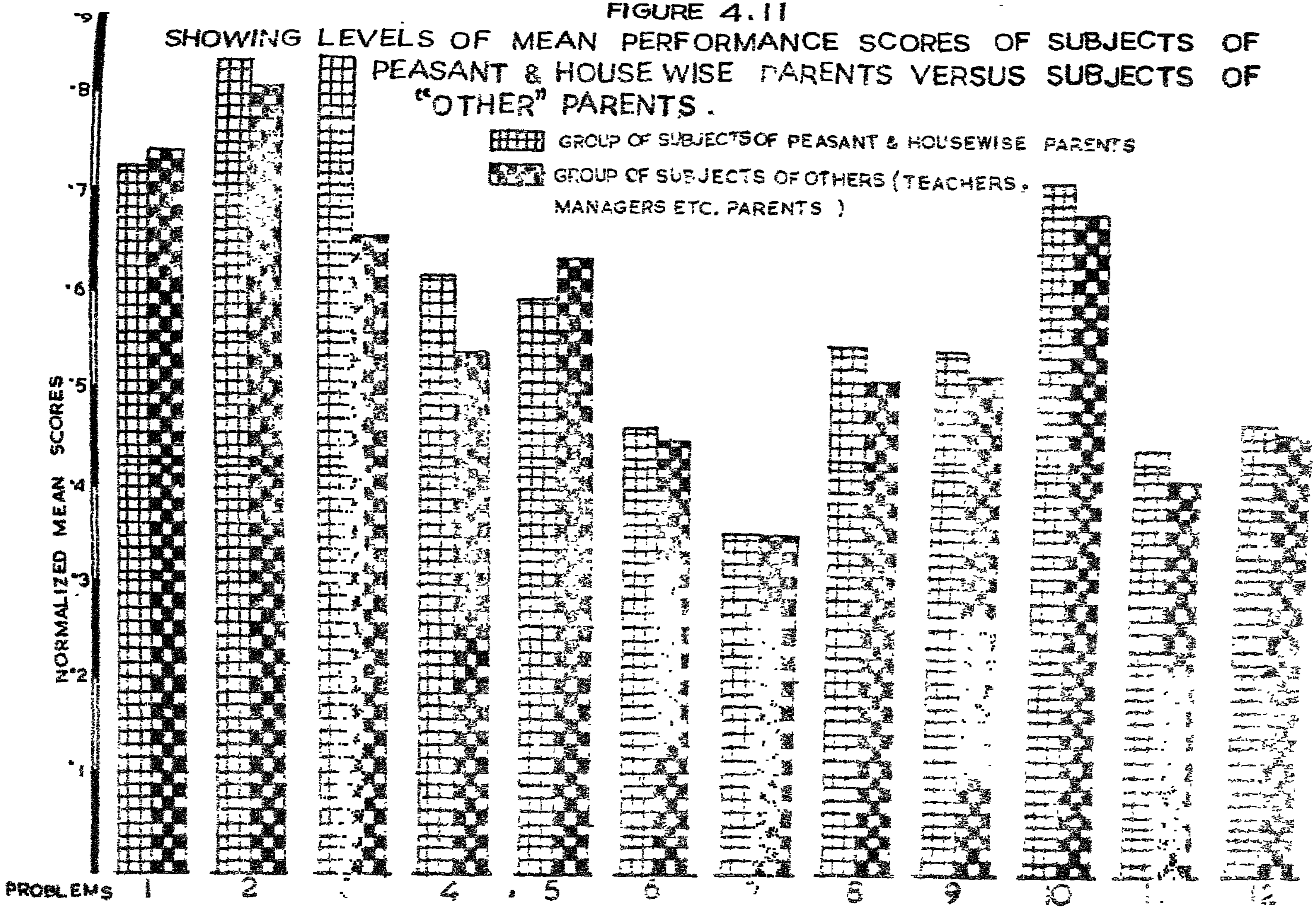
<u>Table 4.16</u>

Showing Mean Performance Scores on Twelve Schemes of Thought Problems with Respect to Parental Occupations

Problem Number	(N = 165) Peasants & Housewives Mean	(N = 105) Others Mean	(N = 270) Total Mean
Prob-1	6.35	6.64	6.46
Prob-2	4.15	4.02	4.10
Prob-3	3.34	3.25	3.30
Prob-4	1.82	1.60	1.74
Prob-5	2.97	3.12	3.03
Prob-6	2.33	2.27	2.30
Prob-7	1.06	1.06	1.06
Prob-8	3.25	3.02	3.16
Prob-9	4.35	4.15	4.27
Prob-10	4.96	4.72	4.87
Prob-11	4.38	4.02	4.24
Prob-12	4.24	4.20	4.22
Total	43.10	41.81	42.60

FIGURE 4.11

SHOWING LEVELS OF MEAN PERFORMANCE SCORES OF SUBJECTS OF PEASANT & HOUSE WISE PARENTS VERSUS SUBJECTS OF "OTHER" PARENTS.



Concluding Statements on Outstanding Findings of the Descriptive Data Analysis

Results of the descriptive statistical analysis of the research data revealed the following key provisional assumptions :

That :

1. The subjects performance in four psychological tests, were hierarchical in the descending order of, Raven's Progressive Matrices Test (RMT); Numerical Abilities Test (NAT); Abstract Reasoning Test (ART); and Verbal Reasoning Test (VRT) (as shown in figure 4.1).

2. Mean performance scores of the subjects on Numerical abilities Test increased with age; but mean performance scores on Verbal Reasoning Test decreased with increase of age (as shown in figures 4.2 and 4.4).

3. Mean performance scores on three psychological tests, namely: Raven's Progressive Matrices; Numerical Abilities Test; and Verbal Reasoning Test, increased with grades, (as shown in figure 4.3).

4. Mean performance scores of the subjects, on Raven's Progressive Matrices, as well as, Numerical Abilities Tests, increased with grades even when grade groups were studied sexwise.

5. An order, (from highest-to-lowest), in Performance scores on twelve schemes of thought problems were indicated(as shown in figures 4.6 and 4.7), as follows, starting from the highest: Combinatorial

Analysis (Prob-3); Using Common Differences (Prob-2); Conservation of Volume (Prob-1); Insightful Figural Knowledge (Prob-10); Classification (Prob-6); Seriation (Prob-5); Stating Hypotheses (Prob-8); Observation, related to Co-ordinate and Perspective Systems (Prob-4); Probability and Chance Occurences (Prob-9); Generalised Logical Thought (Prob-12); Grasping Essence of Problems (Prob-11); and Proportionality (Prob-7).

6. Agewise, insignificant mean score differences existed among the subjects' performances on twelve schemes of thought problems. Higher mean scores obtained by subjects of older age (of 15-16 or more years) are seen ~~in~~ more in number followed by the scores of younger age (of 13-14 years), indicating that, agewise, the subjects functioned only at two levels of logical operations.

7. The subjects performance scores on nearly all (91%), on twelve schemes of thought problems increased with grade.

8. Grade groups studied sexwise, showed performance scores of females, in the middle grade (of senior one), obtaining more lowest mean performance scores; but in the case of males, more mean performance scores are shown increased with grade.

9. The subjects, studied at two categories of, father's, and mother's occupations, showed pupils whose parents were both peasants and housewives obtained more higher mean performance scores, than pupils of "others" parents who obtained better

mean performance scores on such schemes as : Conservation of Volume, and Seriation. Both groups were shown nearly equal on mean scores of: Combinatorial Analysis; Classification; Proportionality; and Generalized Logical Thought.

CHAPTER V

RESULTS AND DISCUSSIONS OF INFERENTIAL DATA ANALYSIS : TESTING THE RESEARCH HYPOTHESES

CHAPTER V

RESULTS AND DISCUSSIONS OF INFERENTIAL DATA ANALYSIS : TESTING THE RESEARCH HYPOTHESES

Restating the Research Hypotheses

Inferential methods of comparing differences between mean scores were employed for testing six hypotheses of the study, for which a substantial computer utilization was made for obtaining statistical values, and other statistical entities. Appendix D shows the planned statistical measures needed for calculating means, medians, modes, standard deviations, correlation coefficients, and 't' values. Results of the analyses were discussed by relating each case to previously similar (in purpose) research findings. Tests of significance were interpreted, using appropriate degrees of freedom. Table 5.1 shows original hypotheses of the study re-stated.

Table 5.1

Showing Seven Original Hypotheses of the Study Restated

S. No.	Abbreviated ref. for the Hypothesis	The Hypotheses, re-stated
1.	Hypothesis - 1	There are no significant differences existing agewise, as well as, gradewise, in Piagetian cognitive development,

among Ugandan pupils tested, on Raven's Progressive Matrices Test, and Differential Aptitude Sub-test of Numerical Ability.

2. Hypothesis - 2 — There are no significant differences existing, agewise, among performance scores of females and males of Ugandan pupils tested, on Raven's Progressive Matrices Test and Differential Aptitude Sub-test of Numerical Ability.

3. Hypothesis - 3 — There are no significant difference existing; agewise, among performance scores of Ugandan pupils studying in three grade groups (of P7, S1 and S2) tested on Twelve Schemes of Thought Problems.

4. Hypothesis - 4 — There are no significant differences existing; gradewise, among performance scores of females and males of Ugandan pupils tested on Twelve Schemes of Thought problems.

5. Hypothesis - 5 — There are no significant differences existing among performance scores of Ugandan pupils of peasant fathers and housewife mothers, and "others" tested on Twelve Schemes of Thought Problems.

6. Hypothesis - 6 — There are no significant differences existing among high and low scorers of Ugandan pupils tested on Twelve Schemes of Thought Problems.

7. Hypothesis - 7 — There does not exist any factorial structure of adolescents thought in Twelve Schemes of Thought Problems administered to Ugandan pupils.

Limits of Significance in
Testing the Hypotheses of the Study

Sample means and standard deviations were used for evolving the statistics employed for comparing two mean differences, in testing six hypotheses of the study. In doing this, note was taken of the fact that measures in the sample were independently drawn from a normal population. The sample means, for that matter, were therefore unbiased estimates of their respective population means, with the standard deviations approximating values of standard errors of the sample statistics. The mean, standard deviation, standard error, along with, the 't' values were computerised. Two tail probability proportions too, were computerised, to guide in the acceptance and rejection limits of the critical regions. Procedures for arranging the tested groups are shown separately, alongwith the procedures for testing the individual hypotheses. In rejecting the null hypothesis, significance levels, lying between the probability estimates of 0.05, and 0.01 were judged, statistically significant. Those lying at less than 0.01 levels were judged, statistically highly significant. The statistics required for testing hypothesis 6 were hand calculated. The analysis, interpretation and discussions on testing hypothesis 7 were undertaken, separately in Chapter VI. Discussions of the results of hypotheses: 1, 2, 3, 4, 5 and 6 were made in groups comprised of hypotheses: 1 and 2, 3 and 4; and 5 and 6.

Results and Discussions of Hypotheses 1 and 2

Hypothesis 1

> There are no significant differences existing; agewise, as well as, gradewise in Piagetian cognitive development among Ugandan pupils tested on : Raven's Progressive Matrices Test, and Differential Aptitude Sub-test of Numerical Ability.

Procedure

The statistics required for testing the hypothesis was computerised using the following specifications of groups of subjects :

(A) Agewise, in which, (1) Group 1 (of 13-14 years) was compared with group 2 (of 14-15 years); (2) Group 2 (of 13-14 years) was compared with group 3 (of 15-16 or more years); and (3) Group 2 (of 14-15 years) was compared with group 3 (of 15-16 or more years).

(B) Gradewise, in which (1) Group 1 (of Primary Seven) was compared with group 2 (of Senior One); (2) Group 1 (of Primary Seven) was compared with group 3 (of Senior Two); and (3) Group 2 (of Senior One) was compared with group 3 (of Senior Two).

Tables 5.2 and 5.3 show the number of cases belonging to each of the groups compared. Details of the statistical values of the groups means, standard deviations, and standard errors, as well as, 't' values, and two-tail probability estimates, are also indicated in the tables.

Table 5.2

Showing the Agewise Number of Cases and the Distribution of the Statistics on Two Psychological Tests : PMT and NAT

Groups compared 1	Number of cases 2	Mean values 3	S.D. values 4	S.E. Values 5	't' values 6	2-Tail Probability Estimates 7
Raven's Progressive Matrices Test (PMT)						
1 (of 13-14 years) with	90	38.511	9.448	0.996	1.10	0.272 N.S.
2 (of 14-15 years)	90	36.878	10.097	1.097		
1 (of 13-14 years) with	90	38.511	9.448	0.996	0.89	0.374 N.S
3 (of 15-16 or more years) with	90	37.200	10.265	1.082		
2 (of 14-15 years) with	90	36.878	10.407	1.097	-0.21	0.835 N.S.
3 (of 15-16 or more years)	90	37.200	10.265	1.082		

Numerical Ability Test (N.[illegible])

1 (of 13-14 years) with	90	19.001	5.686	0.599	-1.16	0.871 N.S.
2 (of 14-15 years)	90	19.156	6.237	0.657		
1 (of 13-14 years) with	90	19.011	5.686	0.599	-1.00	0.317 N.S.
3 (of 15-16 or more years)	90	19.989	7.275	0.767		
2 (of 14-15 years) with	90	19.156	6.237	0.657	-0.87	0.411 N.S.
3 (of 15-16 or more years)	90	19.989	7.275	0.767		

* Statistically significant

** Statistically highly significant

N.S. Not significant

Table 5.3

Showing the Gradewise Number of Cases and the Distributions of the Statistics on Two Psychological Tests: PMT and SAT

Groups compared 1	Number of cases 2	Mean values 3	S.D. values 4	S.E. values 5	't' values 6	2-Tail Probability Estimates 7
		Raven's Progressive Matrices Test (PMT)				
1 (of P7)	78	30.769	10.556	1.195		
with					-5.61	0.000**
2 (of S1)	96	39.325	9.537	0.973		
1 (of P7)	78	30.769	10.556	1.195		
with					-7.81	0.000**
3 (of S2)	96	41.229	7.025	0.717		
2 (of S1)	96	39.325	9.537	0.973		
with					-1.58	0.117 N.S.
3 (of S2)	96	41.229	7.025	0.717		

Numerical Ability Test (N[illegible])

1 (of P7)	78	14.000	2.444	0.277		
with					-7.29	0.000**
2 (of S1)	96	19.177	5.867	0.599		
1 (of P7)	78	14.000	2.444	0.277		
with					-14.40	0.000**
3 (of S2)	96	23.969	5.700	0.582		
2 (of S1)	96	19.177	5.857	0.599		
with					-5.4	0.000**
3 (of S2)	96	23.969	5.700	0.582		

* Statistically significant

** Statistically highly significant

N.S. Not significant

The Results

Tables 5.2 and 5.3 show, respectively the agewise and gradewise comparative groups, and the levels of significance of the differences of performances in Raven's Progressive Matrices Test (PMT) and Differential Aptitude's Sub-Test of Numerical Ability (NAT). Table 5.2 has all three "not significant" differences in PMT as well as in NAT (as appended below in Table 5.4).

Table 5.4

Showing the Tests and the Number of cases of Significance shown in Table 5.2

S.No.	Score Test	Number of cases shown		
		Not Significant	Statistically Significant	Statistically highly significant
1.	Raven's Progressive Matrices (PMT)	3	-	-
2.	Numerical Ability Test (NAT)	3	-	-
	Aggregate	6	-	-

The results indicated that statistically "Not significant" differences existed agewise between performance scores of Ugandan pupils tested on PMT and NAT. But according to the results shown in Table 5.3 one statistically "Not significant" difference and two statistically "Highly significant" differences are shown existed on PMT along with three statistically "Highly significant" differences in NAT (as shown in Table 5.5).

Table 5.5

Showing the tests and the number of cases of significance appearing in Table 5.3

S. No.	Score Test	Number of cases shown Not significant	Statistically significant	Statistically highly significant
1.	Raven's Progressive Matrices (PMT)	1	-	2
2.	Numerical Ability Test (NAT)	-	-	3
	Aggregate	1	-	5

Thus, gradewise there existed statistically "Highly significant" differences between Ugandan pupils tested on PMT and NAT. The null hypothesis was therefore rejected.

Interpretations and discussions of the hypothesis are made jointly with that of hypothesis 2.

Hypothesis 2

There are no significant differences existing, agewise, among performance scores of females and males of Ugandan pupils tested on Raven's Progressive Matrices Test, and Differential Aptitude Sub-test of Numerical Ability.

Procedure

The statistics required for comparison of the differences between two means were computerized, using the following group specifications of :

(A) Females agewise, and (B) Males agewise, in which, (1) Group (of 13-14 years) was compared with group 2 (of 14-15 years); (2) Group 1 (of 13-14 years) was compared with group 3 (of 15-16 or more years); and (3) Group 2 (of 14-15 years) was compared with group 3 (of 15-16 or more years).

Tables 5.6 and 5.7 show the number of cases belonging to each group, and details of the statistical values used.

Table 5.6

Showing the Number of Cases of Females Agewise and the Distributions of the Statistics on Two Psychological Tests: RPMT and AAT

Groups compared	Sex	Number of cases	Mean values	S.D. values	S.E. values	't' values	2-Tail Probability Estimates
1	2	3	4	5	6	7	8
Raven's Progressive Matrices Test (RPMT)							
1 (of 13-14 years) with	Female	29	34.310	11.046	2.051	0.18	0.856 N.S.
2 (of 14-15 years)	Female	29	33.759	12.023	2.233		
1 (of 13-14 years) with	Female	29	34.310	11.046	2.051	0.21	0.834 N.S.
3 (of 15-16 or more years)	Female	29	33.724	10.089	1.873		
2 (of 14-15 years) with	Female	29	33.759	12.023	2.233	0.01	0.991 N.S.
3 (of 15-16 or more years)	Female	29	33.724	10.089	1.873		

Numerical Ability Test (NAT)

1 (of 13-14 years) with	Female	29	15.828	3.152	0.585	0.46	0.645 N.S.
2 (of 14-15 years)	Female	29	15.448	3.089	0.574		
1 (of 13-14 years) with	Female	29	15.828	3.152	0.585	0.74	0.463 N.S.
3 (of 15-16 or more years)	Female	29	15.138	3.916	0.727		
2 (of 14-15 years) with	Female	29	15.448	3.089	0.574	0.34	0.739 N.S.
3 (of 15-16 or more years)	Female	29	15.138	3.916	0.727		

* Statistically significant

** Statistically highly significant

N.S. Not significant

Table 5.7

Showing the Number of Cases of Males Agewise and the Distribution of the Statistics on Two Psychological Tests: RPT and BAT

Group compared	Sex	Number of cases	Mean values	S.D. values	S.E. values	't' Value	2-Tail Probability Estimates
1	2	3	4	5	6	7	8
Raven's Progressive Matrices Test (RPT)							
1 (of 13-14 years) with	Male	61	40.508	7.930	1.015	1.37	0.172 N.S.
2 (of 14-15 years)	Male	61	38.360	9.288	1.189		
1 (of 13-14 years) with	Male	61	40.508	7.930	1.015	1.01	0.311 N.S.
3 (of 15-16 ~~yrs~~ or more years)	Male	61	38.852	10.010	1.282		
2 (of 14-15 years) with	Male	61	38.360	9.288	1.189	-0.28	0.779 N.S.
3 (of 15-16 or more years)	Male	61	38.852	10.010	1.282		

Numerical Ability Test (NAT)

1 (of 13-14 years) with	Male	61	20.525	6.007	0.769	-0.34	0.731 N.S.
2 (of 14-15 years)	Male	61	20.918	6.591	0.844		
1 (of 13-14 years) with	Male	61	20.525	6.007	0.769	-1.45	0.149 N.S.
3 (of 15-16 or more years)	Male	61	22.235	7.388	0.946		
2 (of 14-15 years) with	Male	61	20.918	6.591	0.844	-1.09	0.28C N.S.
3 (of 15-16 or more years)	Male	61	22.295	7.388	0.946		

* Statistically significant

** Statistically highly significant

N.S. Not significant

The Results

Tables 5.6 and 5.7 show the agewise comparative groups, as well as, levels of significance of the differences of mean performance scores on Raven's Progressive Matrices Test (PMT) and Differential Aptitude's sub-test of Numerical Ability Test (NAT). Table 5.6 has shown all the three compared differences on PMT as well as on NAT as being "Not significant" (as appended below in Table 5.8).

Table 5.8

Showing the tests and the number of cases of significance shown in Table 5.6

S. No.	Score Tests	Number of cases shown		
		Not significant	Statistically significant	Statistically highly significant
1.	Raven's Progressive Matrices (PMT)	3	-	-
2.	Numerical Ability Test (NAT)	3	-	-
	Aggregate	6	-	-

Thus indicating that there did not exist significant differences agewise between performance scores of female Ugandan pupils tested on PMT as well as NAT. The same results are found shown in Table 5.7 (as appended in Table 5.9).

Table 5.9

Showing the Tests and number of cases of significance shown in Table 5.7

S. No.	Score Test	Number of cases shown		
		Not significant	Statistically significant	Statistically Highly significant
1.	Raven's Progressive Matrices (PMT)	3	-	-
2.	Numerical Ability Test (NAT)	3	-	-
	Aggregate	6	-	-

Thus, it was found that no"Statistically significant" differences existed agewise among male Ugandan pupils tested on PMT and NAT. Accordingly, the null hypothesis was accepted in both cases of females and males considered agewise.

Interpretations and discussions of the results of the hypothesis was made jointly with that of hypothesis 1.

Interpretation and Discussions of the Results of Hypothesis 1 and 2

The two hypotheses aimed at discovering the subjects categorical, intellectual, as well as, numerical ability differentiations, tested through, mean performance score differences on Raven's Progressive Matrices Test, and Differential Aptitude's Sub-test of Numerical Ability.

While Numerical Ability Test prognosticates intelligence in the gifted or, talented children, Raven's Progressive Matrices Test (Raven 1938 & 1951) is, a Culture Fair Test of intelligence which eschews the use of language or mathematical symbols. Unlike Numerical Ability Test, which calls for skills in performance, Raven's Progressive Matrices Test relies upon measuring observations of differences in pictorial patterns or spatial arrangements as a basis for scoring. Tyler (1972) found little differentiations between performance scores of certain groups of minorities, tested on it.

Investigations on intelligence measurement have revealed sex differences with negligible results. Mosher and Hornsby (1966) found a consistent, age-related answer score patterns. According to Jensen (1969) different ethnic groups of children have similar score distributions on level I intelligence, in which simple associative learning was basic. Piaget (1971) and Piaget _ Inhelder (1969) have confirmed in longitudinal child studies that, children can

perform actual or mental operations in a systematic way. The findings underlie children's capacity to classify, to order objects in logical seriation and to conserve the essentials of a stimulus as the elements go through transformation. They found chronological age exerting more weight in children's capacity and degree to success, compared to sex or mental advantages or dis-advantages. The obtained results of Hypothesis-1 and Hypothesis-2 have some similarities and dissimilarities with those other results cited.

According to Hypothesis-1 differences existed gradewise in the two tests, On considering effects of sex in Hypothesis 2, it was found that no differences existed agewise among both females and males.

The results were interpreted as showing categorical differentiations of stages of cognitive development existing gradewise among the groups of Ugandan Pupils tested. The subjects were therefore found made-up of both concrete and formal operational thinkers.

Results and Discussions of Hypotheses 3 and 4

Hypothesis 3

> There are no significient differences existing, agewise, among performance scores of Ugandan pupils, studying in three grade groups (of Primary Seven, Senior One, and Senior Two) tested, on twelve schemes of thought problems.

Procedure

The statistics required for comparing the differences, was computerised, using the following group specifications of grade, in which (1) P7 (Primary Seven) of age group 1 (of 13-14 years) was compared with P7 (Primary Seven) of age group 2 (of 14-15 years); and (2) P7 (Primary Seven) of age group 1 (of 13-14 years) was compared with P7 (Primary Seven) of age group 3 (of 15-16 or more years); (3) P7 (Primary Seven) of age group 2 (of 14-15 years) was compared with P7 (Primay Seven) of age group 3 (of 15-16 or more years); (4) S1 (Senior One) of age group 1 (of 13-14 years) was compared with S1 (Senior One) of age group 2 (of 14-15 years); (5) S1 (Senior One) of age group 1 (of 13-14 years) was compared with S1 (Senior One) of age group 3 (of 15-16 or more years); (6) S1 (Senior One) of age group 2(of 14-15 years) was compared with S1 (Senior One) of age group 3 (of 13-16 or more years); (7) S2 (Senior Two) of age group 1 (of 13-14 years) was compared with S2 (Senior Two) of age group 2 (of 14-15 years); (8) S2 (Senior

Two) of age group 1 (of 13-14 years) was compared with S2 (Senior Two) of age group 3 (of 15-16 or more years); (9) S2 (Senior Two) of age group 2 (of 14-15 years) was compared with S2 (Senior Two) of age group 3 (of 15-16 or more years).

Table 5.10 shows the number of cases belonging to each group, as well as, details of the values of the statistics used in testing the hypothesis.

The Results

Table 5.10 shows the agewise comparative groups of each grade, and the levels of significance, of the differences of mean scores on each of the twelve schemes of thought problems, including also, on the total problem scores. A summary for the results is shown in table 5.11.

Contd.

Table 5.10

Showing the Number of Cases of Each grade Group, Agewise, and the Distribution of the Statistics on Twelve Schemes of Thought Problems

Groups compared 1	Grades 2	Number of cases 3	Mean values 4	S.D. values 5	S.E. Values 6	't' values 7	2-Tail Probability Estimates 8
			Problem 1				
1 (of 13-14 years) with	P7	26	6.154	1.690	0.331	0.18	0.857 N.S.
2 (of 14-15 years)	P7	26	6.077	1.354	0.266		
1 (of 13-14 years) with	P7	26	6.154	1.690	0.331	0.32	0.751 N.S.
3 (of 15-16 or more years)	P7	26	6.000	1.789	0.351		
2 (of 14-15 years) with	P7	26	6.077	1.354	0.266	0.17	0.862 N.S.
3 (of 15-16 or more years)	P7	26	6.000	1.789	0.351		
1 (of 13-14 years) with	S1	32	6.281	1.250	0.221	0.18	0.857 N.S.
2 (of 14-15 years)	S1	32	6.219	1.497	0.265		
1 (of 13-14 years) with	S1	32	6.281	1.250	0.221	-0.84	0.407 N.S.
3 (of 15-16 or more years,	S1	32	6.563	1.435	0.254		

2 (of 14-15 years) with	S1	32	6.219	1.497	0.265	-0.94	0.352 N.S.
3 (of 15-16 or more years)	S1	32	6.565	1.435	0.254		
1 (of 13-14 years) with	S2	32	6.969	1.515	0.267	-0.58	0.566 N.S.
2 (of 14-15 years)	S2	32	7.219	1.930	0.341		
1 (of 13-14 years) with	S2	32	6.969	1.515	0.267	1.43	0.157 N.S.
3 (of 15-16 or more years)	S2	32	6.469	1.270	0.224		
2 (of 14-15 years) with	S2	32	7.219	1.930	0.341	1.84	0.071 N.S.
3 (of 15-16 or more years)	S2	32	6.469	1.270	0.224		

Problem 2

1 (of 13-14 years) with	P7	26	5.751	1.430	0.280	-0.31	0.756 N.S.
2 (of 14-15 years)	P7	26	5.846	1.223	0.240		
1 (of 13-14 years) with	P7	26	5.751	1.430	0.280	-0.20	0.841 N.S.
3 (of 15-16 or more years)	P7	26	5.808	1.327	0.260		
2 (of 14-15 years) with	P7	26	5.846	1.223	0.240	-0.11	0.914 N.S.
3 (of 15-16 or more years)	P7	26	5.808	1.327	0.260		

1 (of 13-14 years) with	S1	32	4.031	1.257	0.222	-0.22	0.830 N.S.
2 (of 14-15 years)	S1	32	4.094	1.058	0.187		
1 (of 13-14 years) with	S1	32	4.031	1.257	0.222	-1.48	0.144 N.S.
3 (of 15-16 or more years)	S1	32	4.438	0.914	0.162		
2 (of 14-15 years) with	S1	32	4.094	1.058	0.187	-1.39	0.169 N.S.
3 (of 15-16 or more years)	S1	32	4.438	0.914	0.162		
1 (of 13-14 years) with	S2	32	4.438	0.878	0.155	1.84	0.076 N.S
2 (of 14-15 years)	S2	32	4.000	1.016	0.180		
1 (of 13-14 years) with	S2	32	4.438	0.875	0.155	0.55	0.582 N.S.
3 (of 15-16 or more years)	S2	32	4.313	0.931	0.165		
2 (of 14-15 years) with	S2	32	4.000	1.016	0.180	-1.28	0.204 N.S
3 (of 15-16 or more years)	S2	32	4.313	0.931	0.165		

Problem 3

1 (of 13-14 years) with	P7	26	3.154	1.225	0.240	0.84	0.404 N.S.
2 (of 14-15 years)	P7	26	2.846	1.405	0.276		

1 (of 13-14 years) with	F7	26	3.154	1.223	0.240	0.11	0.913 N.S.
3 (of 15-16 or more years)	F7	26	3.115	1.306	0.256		
2 (of 14-15 years) with	F7	26	2.846	1.405	0.276	-0.72	0.478 N.S.
3 (of 15-16 or more years)	F7	26	3.115	1.306	0.256		
1 (of 13-14 years) with	S1	32	2.969	1.448	0.256	-0.45	0.655 N.S.
2 (of 14-15 years)	S1	32	3.125	1.338	0.237		
1 (of 13-14 years) with	S1	32	2.969	1.448	0.256	-2.50	0.015*
3 (15-16 or more years)	S1	32	3.719	0.888	0.157		
2 (of 14-15 years) with	S1	32	3.125	1.338	0.237	-2.09	0.041*
3 (of 15-16 or more years)	S1	32	3.719	0.888	0.157		
1 (of 13-14 years) with	S2	32	3.531	1.047	0.185	0.64	0.525 N.S.
2 (of 14-15 years)	S2	32	3.344	1.285	0.227		
1 (of 13-14 years) with	S2	32	3.531	1.047	0.185	-1.14	0.257 N.S.
3 (of 15-16 or more years)	S2	32	3.781	0.659	0.117		

2 (of 14-15 years) with	52	32	3.344	1.285	0.227	-1.71	0.092 N.S.
3 (of 15-16 or more years)	52	32	3.781	0.659	0.117		

Problem 4

1 (of 13-14 years) with	27	26	1.425	0.809	0.159	-1.40	0.166 N.S.
2 (of 14-15 years)	27	26	1.692	0.549	0.108		
1 (of 13-14 years) with	27	26	1.425	0.809	0.159	-0.71	0.482 N.S.
3 (of 15-16 or more years)	27	26	1.577	0.758	0.149		
2 (of 14-15 years) with	27	26	1.692	0.549	0.108	0.63	0.532 N.S.
3 (of 15-16 or more years)	27	26	1.577	0.758	0.149		
1 (of 13-14 years) with	51	32	1.688	0.644	0.114	0.38	0.705 N.S.
2 (of 14-15 years)	51	32	1.625	0.660	0.117		
1 (of 13-14 years) with	51	32	1.688	0.644	0.114	-0.62	0.534 N.S.
3 (of 15-16 or more years)	51	32	1.781	0.553	0.098		
2 (of 14-15 years) with	51	32	1.625	0.660	0.117	-1.03	0.308 N.S.
3 (of 15-16 or more years)	51	32	1.781	0.553	0.098		

1 (of 13-14 years) with	S2	32	1.875	0.707	0.125	-0.75	0.456 N.S.
2 (of 14-15 years)	S2	32	2.000	0.622	0.110		
1 (of 13-14 years) with	S2	32	1.875	0.707	0.125	-0.0	1.000 N.S.
3 (of 15-16 or more years)	S2	32	1.875	0.554	0.098		
2 (of 14-15 years) with	S2	32	2.000	0.622	0.110	0.85	0.39[illegible] N.S.
3 (of 15-16 or more years)	S2	32	1.875	0.554	0.098		

Problem 5

1 (of 13-14 years) with	P7	26	3.115	0.864	0.169	2.00	0.051*
2 (of 14-15 years)	P7	26	2.615	0.941	0.185		
1 (of 13-14 years) with	P7	26	3.115	0.864	0.169	3.09	0.003**
3 (of 15-16 or more years)	P7	26	2.231	1.177	0.231		
2 (of 14-15 years) with	P7	26	2.615	0.941	0.185	1.30	0.199 N.S.
3 (of 15-16 or more years)	P7	26	2.231	1.177	0.231		
1 (of 13-14 years) with	S1	32	2.906	0.818	0.145	0.40	0.693 N.S.
2 (of 14-15 years)	S1	32	2.813	1.061	0.188		

1 (of 13-14 years) with	E1	32	2.906.	0.818	0.145	-1.69	0.097 N.S.
3 (of 15-16 or more years)	E1	32	3.312	1.091	0.193		
2 (of 14-15 years) with	E1	32	2.813	1.061	0.188	-1.86	0.066 N.S.
3 (of 15-16 or more years)	E1	32	3.312	1.091	0.193		
1 (of 13-14 years) with	E2	32	3.219	0.906	0.160	-1.37	0.175 N.S.
2 (of 14-15 years)	E2	32	3.531	0.915	0.162		
1 (of 13-14 years) with	E2	32	3.219	0.906	0.160	-0.42	0.673 N.S.
3 (of 15-16 or more years)	E2	32	3.313	0.859	0.152		
2 (of 14-15 years) with	E2	32	3.531	0.915	0.162	0.99	0.326 N.S.
3 (of 15-16 or more years)	E2	32	3.313	0.859	0.152		

<u>Problem 6</u>

1 (of 13-14 years) with	P7	26	1.885	1.608	0.315	0.92	0.360 N.S.
2 (of 14-15 years)	P7	26	1.539	1.029	0.202		
1 (of 13-14 years) with	P7	26	1.885	1.608	0.315	0.39	0.696 N.S.
3 (of 15-16 or more years)	P7	26	1.731	1.185	0.232		

2 (of 14-15 years) with	P7	26	1.539	1.029	0.202	-0.62	0.537 N.S.
3 (of 15-16 or more years)	P7	26	1.731	1.185	0.232		
1 (of 13-14 years) with	S1	32	1.969	1.332	0.235	-0.61	0.547 N.S.
2 (of 14-15 years)	S1	32	2.156	1.139	0.201		
1 (of 13-14 years) with	S1	32	1.969	1.332	0.235	-2.00	0.050*
3 (of 15-16 or more years)	S1	32	2.625	1.289	0.228		
2 (of 14-15 years) with	S1	32	2.156	1.139	0.201	-1.54	0.128 N.S.
3 (of 15-16 or more years)	S1	32	2.625	1.289	0.228		
1 (of 13-14 years) with	S2	32	2.875	1.362	0.241	-0.61	0.542 N.S.
2 (of 14-15 years)	S2	32	3.094	1.489	0.263		
1 (of 13-14 years) with	S2	32	2.875	1.362	0.241	1.01	0.317 N.S.
3 (of 15-16 or more years)	S2	32	2.563	1.105	0.195		
2 (of 14-15 years) with	S2	32	3.094	1.489	0.263	1.62	0.110 N.S.
3 (of 15-16 or more years)	S2	32	2.563	1.105	0.195		

Problem 7

1 (of 13–14 years) with	P7	26	0.769	0.710	0.139	0.00	1.000 N.S.
2 (of 14–15 years)	P7	26	0.769	0.587	0.115		
1 (of 13–14 years) with	P7	26	0.769	0.710	C.139	–1.26	0.213 N.S.
3 (of 15–16 or more years)	P7	26	1.059	0.824	0.162		
2 (of 14–15 years) with	P7	26	0.769	0.587	0.115	–1.36	0.181 N.S.
3 (of 15–16 or more years)	P7	26	1.059	0.824	0.162		
1 (of 13–14 years) with	S1	32	1.031	0.782	0.138	0.81	0.418 N.S.
2 (of 14–15 years)	S1	32	0.875	0.751	0.133		
1 (of 13–14 years) with	S1	32	1.031	0.782	0.138	–0.78	0.436 N.S.
3 (of 15–16 or more years)	S1	32	1.156	0.448	0.079		
2 (of 14–15 years) with	S1	32	0.875	0.751	0.133	–1.82	0.074 N.S.
3 (of 15–16 or more years)	S1	32	1.156	0.448	0.079		
1 (of 13–14 years) with	S2	32	1.156	0.847	0.150	–1.23	0.224 N.S.
2 (of 14–15 years)	S2	32	1.438	0.982	0.174		

1 (of 13-14 years)	S2	32	1.156	0.847	0.150		
with						-0.14	0.886 N.S.
3 (of 15-16 or more years)	S2	32	1.188	0.896	0.158		
2 (of 14-15 years)	S2	32	1.438	0.982	0.174		
with						1.06	0.291 N.S.
3 (of 15-16 or more years)	S2	32	1.188	0.896	0.158		

Problem 8

1 (of 13-14 years)	P7	26	3.000	1.020	0.200		
with						0.45	0.654 N.S.
2 (of 14-15 years)	P7	26	2.885	0.816	0.160		
1 (of 13-14 years)	P7	26	3.000	1.020	0.200		
with						1.13	0.265 N.S.
3 (of 15-16 or more years)	P7	26	2.731	0.667	0.131		
2 (of 14-15 years)	P7	26	2.885	0.816	0.160		
with						0.74	0.460 N.S.
3 (of 15-16 ~~ya~~ or more years)	P7	26	2.731	0.667	0.131		
1 (of 13-14 years)	S1	32	2.938	0.982	0.174		
with						-0.86	0.394 N.S.
2 (of 14-15 years)	S1	32	3.125	0.751	0.133		
1 (of 13-14 years)	S1	32	2.938	0.982	0.174		
with						-1.91	0.060 N.S.
3 (of 15-16 or more years)	S1	32	3.406	0.979	0.173		

2 (of 14-15 years) with	E1	32	3.125	0.751	0.133	-1.29	0.202 N.S.
3 (of 15-16 or more years)	E1	32	3.406	0.979	0.173		
1 (of 13-14 years) with	E2	32	3.250	1.136	0.201	-0.22	0.827 N.S.
2 (of 14-15 years)	E2	32	3.313	1.148	0.203		
1 (of 13-14 years) with	E2	32	3.250	1.136	0.201	-1.44	0.156 N.S.
3 (of 15-16 or more years)	E2	32	3.625	0.942	0.166		
2 (of 14-15 years) with	E2	32	3.313	1.148	0.203	-1.19	0.236 N.S.
3 (of 15-16 or more years)	E2	32	3.625	0.942	0.166		

Problem 9

1 (of 13-14 years) with	F7	26	4.154	1.223	0.240	0.75	0.455 N.S.
2 (of 14-15 years)	F7	26	3.962	0.445	0.087		
1 (of 13-14 years) with	F7	26	4.154	1.223	0.240	0.52	0.607 N.S.
3 (of 15-16 or more years)	F7	26	4.000	0.894	0.175		
2 (of 14-15 years) with	F7	26	3.962	0.445	0.087	-0.20	0.845 N.S.
3 (of 15-16 or more years)	F7	26	4.000	0.894	0.175		

1 (of 13–14 years) with	S1	32	3.969	0.695	0.123	-1.65	0.105 N.S.
3 (of 15–16 or more years)	S1	32	4.250	0.672	0.119		
2 (of 14–15 years) with	S1	32	4.031	0.595	0.105	-1.38	0.173 N.S.
3 (of 15–16 or more years)	S1	32	4.250	0.672	0.119		
1 (of 13–14 years) with	S2	32	4.625	1.621	0.287	-0.70	0.486 N.S.
2 (of 14–15 years)	S2	32	4.938	1.933	0.342		
1 (of 13–14 years) with	S2	32	4.625	1.621	0.287	0.70	0.484 N.S.
3 (of 15–16 or more years)	S2	32	4.375	1.185	0.209		
2 (of 14–15 years) with	S2	32	4.938	1.933	0.342	1.40	0.165 N.S.
3 (of 15–16 or more years)	S2	32	4.375	1.185	0.209		

Problem 10

1 (of 13–14 years) with	P7	26	4.962	1.661	0.326	0.28	0.781 N.S.
2 (of 14–15 years)	P7	26	4.846	1.287	0.252		

1 (of 13-14 years) with	P7	26	4.362	1.661	0.326	1.32	0.192 N.S
3 (of 15-16 or more years)	P7	26	4.346	1.696	0.333		
2 (of 14-15 years) with	P7	26	4.846	1.287	0.252	1.20	0.237 N.S
3 (of 15-16 or more years)	P7	26	4.346	1.696	0.333		
1 (of 13-14 years) with	S1	32	4.750	1.136	0.201	0.94	0.349 N.S
2 (of 14-15 years)	S1	32	4.469	1.244	0.220		
1 (of 13-14 years) with	S1	32	4.750	1.136	0.201	-0.20	0.839 N.S.
3 (of 15-16 or more years)	S1	32	4.813	1.306	0.231		
2 (of 14-15 years) with	S1	32	4.469	1.244	0.220	-1.08	0.285 N.S.
3 (of 15-16 or more years)	S1	32	4.813	1.306	0.231		
1 (of 13-14 years) with	S2	32	5.188	1.148	0.203	1.01	0.317 N.S.
2 (of 14-15 years)	S2	32	8.444	1.547	0.274		
1 (of 13-14 years) with	S2	32	5.188	1.148	0.203	-1.15	0.253 N.S.
3 (of 15-16 or more years)	S2	32	5.500	1.016	0.180		

2 (of 14-15 years) with	S2	32	4.844	1.547	0.274	-2.01	0.049*
3 (of 15-16 or more years)	S2	32	5.500	1.016	0.180		

Problem 11

1 (of 13-14 years) with	P7	26	3.808	1.833	0.360	1.12	0.269 N.S.
2 (of 14-15 years)	P7	26	3.269	1.638	0.320		
1 (of 13-14 years) with	P7	26	3.808	1.833	0.360	1.27	0.209 N.S.
3 (of 15-16 or more years)	P7	26	3.192	1.650	0.324		
2 (of 14-15 years) with	P7	26	3.269	1.638	0.320	0.17	0.867 N.S.
3 (of 15-16 or more years)	P7	26	3.192	1.650	0.324		
1 (of 13-14 years) with	S1	32	4.188	1.908	0.337	0.57	0.571 N.S.
2 (of 14-15 years)	S1	32	3.938	1.585	0.280		
1 (of 13-14 years) with	S1	32	4.188	1.908	0.337	-0.35	0.730 N.S.
3 (of 15-16 or more years)	S1	32	4.344	1.696	0.300		
2 (of 14-15 years) with	S1	32	3.938	1.585	0.280	-0.99	0.326 N.S.
3 (of 15-16 or more years)	S1	32	3.344	1.696	0.300		

1 (of 13-14 years) with	32	32	4.656	1.994	0.352	-0.59	0.560 N.S.
3 (of 15-16 or more years)	32	32	4.969	2.265	0.400		
2 (of 14-15 years) with	32	32	5.315	1.804	0.319	0.67	0.504 N.S.
3 (of 15-16 or more years)	32	32	4.969	2.265	0.400		

Problem 12

1 (of 13-14 years) with	27	26	3.962	1.886	0.370	-0.33	0.745 N.S.
2 (of 14-15 years)	27	26	4.115	1.479	0.290		
1 (of 13-14 years) with	27	26	3.962	1.886	0.370	-0.70	0.487 N.S.
3 (of 15-16 or more years)	27	26	4.308	1.668	0.327		
2 (of 14-15 years) with	27	26	4.115	1.479	0.290	-0.44	0.662 N.S.
3 (of 15-16 or more years)	27	26	4.308	1.668	0.327		
1 (of 13-14 years) with	31	32	3.781	1.184	0.209	0.34	0.737 N.S.
2 (of 14-15 years)	31	32	3.680	1.030	0.182		

1 (of 13-14 years) with	S1	32	3.781	1.184	0.209	0.21	0.836 N.S.
3 (of 15-16 or more years)	S1	32	3.719	1.250	0.221		
2 (of 14-15 years) with	S1	32	3.688	1.030	0.182	-0.11	0.913 N.S.
3 (of 15-16 or more years)	S1	32	3.719	1.250	0.221		
1 (of 13-14 years) with	S2	32	5.063	2.094	0.370	-0.23	0.821 N.S.
2 (of 14-15 years)	S2	32	5.188	2.292	0.405		
1 (of 13-14 years) with	S2	32	5.063	2.094	0.370	1.92	0.059 N.S.
3 (of 15-16 or more years)	S2	32	4.125	1.792	0.317		
2 (of 14-15 years) with	S2	32	5.188	2.292	0.405	2.07	0.043*
3 (of 15-16 or more years)	S2	32	4.125	1.792	0.317		

<u>Total Problems</u>

1 (of 13-14 years) with	P7	26	40.115	7.732	1.516	0.75	0.455 N.S
2 (of 14-15 years)	P7	26	38.615	6.591	1.293		
1 (of 13-14 years) with	P7	26	40.115	7.732	1.516	1.00	0.323 N.S.
3 (of 15-16 or more years)	P7	26	37.962	7.836	1.537		

2 (of 14-15 years) with	K7	26	38.615	6.591	1.293	0.33	0.746 N.S.
3 (of 15-16 or more years)	K7	26	37.962	7.836	1.537		
1 (of 13-14 years) with	S1	32	40.500	8.584	1.517	0.40	0.692 N.S.
2 (of 14-15 years)	S1	32	39.719	7.113	1.257		
1 (of 13-14 years) with	S1	32	40.500	8.584	1.517	-1.84	0.071 N.S.
3 (of 15-16 or more years)	S1	32	44.156	7.278	1.287		
2 (of 14-15 years) with	S1	32	39.719	7.113	1.257	-2.47	0.016*
3 (of 15-16 or more years)	S1	32	44.156	7.278	1.287		
1 (of 13-14 years) with	S2	32	46.844	5.815	1.028	-0.59	0.558 N.S.
2 (of 14-15 years)	S2	32	47.906	8.387	1.483		
1 (of 13-14 years) with	S2	32	46.844	5.815	1.028	0.87	0.385 N.S.
3 (of 15-16 or more years)	S2	32	45.500	6.461	1.142		
2 (of 14-15 years) with	S2	32	47.906	8.387	1.483	1.29	0.203 N.S.
3 (of 15-16 or more years)	S2	32	45.500	6.461	1.142		

* Statistically significant
** Statistically highly significant
N.S. Not significant

Table 5.11

Showing the Number of Levels of Significance of Mean Score Differences on Twelve Schemes of Thought Problems, including that of Total Problems

S. No.	Schemes of thought and (Problem Nos.)	Number of cases shown for Not significant	Statistically significant	Statistically highly significant
1.	Conservation of Volume (Prob-1)	9	-	-
2.	Using Common Differences (Prob-2)	9	-	-
3.	Combinatorial Analysis (Prob-3)	7	2	-
4.	Observation Perspective (Prob-4)	9	-	-
5.	Seriation (Prob-5)	7	1	1
6.	Classification (Prob-6)	9	-	-
7.	Proportionality (Prob-7)	9	-	-
8.	Stating Hypotheses (Prob-8)	9	-	-
9.	Probabilistic Reasoning (Prob-9)	9	-	-
10.	Insightful figural knowledge (Prob-10)	8	1	-
11.	Grasping Essence of Problem (Prob-11)	9	-	-
12.	Generalised logical Thought (Prob-12)	8	1	-
	Aggregate*	8	1	-

* Are not the sum of the figures from above, but the significance levels of the Total Problems' Scores.

Accordingly, table 5.11 reveals only one statistically significant difference existing on the average on the twelve schemes of thought problems. As such, the null hypothesis was, therefore, accepted in the case of all the schemes of the thought problems. Discussions on the results are made jointly with that of the results of hypothesis-4.

<u>Hypothesis-4</u>

> There are no significant differences existing; gradewise, among performance scores of females and males of Ugandan pupils tested, on twelve schemes of thought problems.

<u>Procedure</u>

The statistics required for testing the hypothesis was computerised using the following grade group specifications, in which mean performance scores of : (1) Females in grade group 1 (of P7) was compared with those of grade group 2 (of S1); (2) Females in grade group 1 (of P7) was compared with those of grade group 3 (of S2); (3) Females in grade group 2 (of S1) was compared with those of grade group 3 (of S2); (4) Males in grade group 1 (of P7) was compared with those of grade group 2 (of S1); (5) Males of grade group 1 (of P7) was compared with those of grade group 3 (of S2); and (6) Males of grade group 2 (of S1) was compared with those of grade group 3 (of S2).

Table 5.12 shows the number of cases belonging to each group.

Table 5.12

Showing the Number of Cases of Females and Males, Gradewise, and the Distribution of the Statistics on Each of the Twelve Schemes of Thought problems

Group compared 1	Sex 2	Number of cases 3	Mean Values 4	S.D. values 5	S.E. Values 6	't' Values 7	2-Tail Probability Estimates 8
Problem 1							
1 (of P7) with	Female	39	5.795	1.559	0.250	-1.35	0.185 N.S.
2 (of S1)	Female	24	6.292	1.160	0.237		
1 (of P7) with	Female	39	5.795	1.559	0.250	-1.45	0.155 N.S.
3 (of S2)	Female	24	6.333	1.204	0.246		
2 (of S1) with	Female	24	6.292	1.160	0.277	-0.12	0.905 N.S.
3 (of S2)	Female	24	6.333	1.204	0.246		
1 (of P7) with	Male	39	6.359	1.614	0.258	-0.05	0.958 N.S.
2 (of S1)	Male	72	6.375	1.467	0.173		
1 (of P7) with	Male	39	6.359	1.614	0.258	-2.15	0.034*
3 (of S2)	Male	72	7.069	1.689	0.199		
2 (of S1) with	Male	72	6.375	1.467	0.173	-2.63	0.009**
3 (of S2)	Male	72	7.069	1.682	0.199		

Problem 2

1 (of P7) with	Female	39	4.000	1.214	0.194	0.00	1.000 N.S.
2 (of S1)	Female	24	4.000	1.142	0.233		
1 (of P7) with	Female	39	4.000	1.214	0.194	-0.56	0.575 N.S.
3 (of S2)	Female	24	4.167	1.007	0.206		
2 (of S1) with	Female	24	4.000	1.142	0.233	-0.54	0.594 N.S.
3 (of S2)	Female	24	4.167	1.007	0.206		
1 (of P7) with	Male	39	3.590	1.390	0.223	-2.79	0.006**
2 (of S1)	Male	72	4.250	1.071	0.126		
1 (of P7) with	Male	39	3.590	1.390	0.223	-3.10	0.002**
3 (of S2)	Male	72	4.278	0.938	0.111		
2 (of S1) with	Male	72	4.250	1.071	0.126	-0.17	0.869 N.S.
3 (of S2)	Male	72	4.278	0.938	0.111		

Problem 3

1 (of P7) with	Female	39	3.077	1.345	0.215	0.79	0.434 N.S.
2 (of S1)	Female	24	2.792	1.474	0.301		
1 (of P7) with	Female	39	3.077	1.345	0.215	-2.19	0.032*
3 (of S2)	Female	24	3.750	0.847	0.173		

2 (of S1) with	Female	24	2.792	1.474	0.301	-2.76	0.008**
3 (of S2)	Female	24	3.750	0.847	0.175		
1 (of P7) with	Male	39	3.000	1.277	0.205	-1.79	0.076 N.S.
2 (of S1)	Male	72	3.431	1.175	0.138		
1 (of P7) with	Male	39	3.000	1.277	0.205	-2.11	0.037*
3 (of S2)	Male	72	3.486	1.088	0.128		
2 (of S1) with	Male	72	3.431	1.175	0.138	-0.29	0.769 N.S.
3 (of S2)	Male	72	3.486	1.088	0.128		

<u>Problem 4</u>

1 (of P7) with	Female	39	1.615	0.711	0.114	0.67	0.509 N.S.
2 (of S1)	Female	24	1.500	0.590	0.120		
1 (of P7) with	Female	39	1.615	0.711	0.114	-2.02	0.048*
2 (of S2)	Female	24	1.958	0.550	0.112		
2 (of S1) with	Female	39	1.500	0.590	0.120	-2.78	0.008**
3 (of S2)	Female	24	1.958	0.550	0.112		
1 (of P7) with	Male	39	1.513	0.721	0.115	-1.93	0.056 N.S.
2 (of S1)	Male	72	1.764	0.617	0.073		

1 (of P7) with	Male	39	1.515	0.721	0.115	-2.89	0.005**
3 (of S2)	Male	72	1.905	0.655	0.077		
2 (of S1) with	Male	72	1.764	0.617	0.073	-1.31	0.192 N.S.
3 (of S2)	Male	72	1.305	0.655	0.077		

Problem 5

1 (of P7) with	Female	39	2.564	1.071	0.172	-1.74	0.086 N.S.
2 (of S1)	Female	24	3.042	1.042	0.215		
1 (of P7) with	Female	39	2.564	1.071	0.172	-2.61	0.011**
3 (of S2)	Female	24	3.292	1.083	0.221		
2 (of S1) with	Female	24	3.042	1.042	0.215	-0.82	0.419 N.S.
3 (of S2)	Female	24	3.292	1.083	0.221		
1 (of P7) with	Male	39	2.744	1.044	0.167	-1.26	0.209 N.S.
2 (of S1)	Male	72	3.000	1.007	0.119		
1 (of P7) with	Male	39	2.744	1.044	0.167	-3.49	0.001**
3 (of S2)	Male	72	3.375	0.850	0.098		
2 (of S1) with	Male	72	3.000	1.007	0.119	-2.44	0.016*
3 (of S2)	Male	72	3.375	0.850	0.098		

Problem 6

1 (of P7)	Female	39	1.410	1.371	0.220		
with						0.40	0.68[illegible] N.S.
2 (of S1)	Female	24	1.292	0.550	0.112		
1 (of P7)	Female	39	1.410	1.371	0.220		
with						-2.53	0.014*
3 (of S2)	Female	24	2.167	0.637	0.130		
2 (of S1)	Female	24	1.292	0.550	0.112		
with						-5.09	0.000**
3 (of S2)	Female	24	2.167	0.637	0.130		
1 (of P7)	Male	39	2.026	1.135	0.182		
with						-2.21	0.029*
2 (of S1)	Male	72	2.569	1.287	0.152		
1 (of P7)	Male	39	2.026	1.135	0.182		
with						-3.94	0.000**
3 (of S2)	Male	72	3.069	1.427	0.168		
2 (of S1)	Male	72	2.569	1.287	0.152		
with						-2.21	0.029*
3 (of S2)	Male	72	3.069	1.427	0.168		

Problem 7

1 (of P7)	Female	39	0.949	0.724	0.116		
with						1.16	0.249 N.S.
2 (of S1)	Female	24	0.750	0.552	0.109		

1 (of F7) with	Female	39	0.949	0.724	0.116	-0.06	0.956 N.S.
3 (of S2)	Female	24	0.958	0.550	0.112		
2 (of S1) with	Female	24	0.750	0.532	0.109	-1.33	0.189 N.S.
3 (of S2)	Female	24	0.958	0.550	0.112		
1 (of F7) with	Male	39	0.769	0.706	0.113	-2.44	0.016*
2 (of S1)	Male	72	1.111	0.705	0.083		
1 (of F7) with	Male	39	0.769	0.706	0.113	-3.32	0.001**
3 (of S2)	Male	72	1.361	0.983	0.116		
2 (of S1) with	Male	72	1.111	0.705	0.083	-1.76	0.081 N.S.
3 (of S2)	Male	72	1.361	0.983	0.116		

Problem 8

1 (of F7) with	Female	39	2.872	0.951	0.152	2.16	0.035*
2 (of S1)	Female	24	2.417	0.504	0.103		
1 (of F7) with	Female	39	2.872	0.951	0.152	-0.45	0.671 N.S.
3 (of S2)	Female	24	2.958	0.359	0.073		
2 (of S1) with	Female	24	2.417	0.504	0.103	-4.29	0.000**
3 (of S2)	Female	24	2.958	0.359	0.073		

1 (of P7)	Male	39	2.872	0.732	0.117		
with						-3.16	0.002**
2 (of S1)	Male	72	3.403	0.899	0.106		
1 (of P7)	Male	39	2.872	0.732	0.117		
with						-3.18	0.002**
3 (of S2)	Male	72	3.542	1.198	0.141		
2 (of S1)	Male	72	3.403	0.899	0.106		
with						-0.79	0.433 N.S.
3 (of S2)	Male	72	3.542	1.198	0.141		

Problem 9

1 (of P7)	Female	39	3.949	0.793	0.127		
with						0.84	0.405 N.S.
2 (of S1)	Female	24	3.792	0.588	0.120		
1 (of P7)	Female	39	3.949	0.793	0.127		
with						-0.74	0.460 N.S.
3 (of S2)	Female	24	4.083	0.504	0.103		
2 (of S1)	Female	24	3.792	0.588	0.120		
with						-1.85	0.071 N.S.
3 (of S2)	Female	24	4.083	0.504	0.103		
1 (of P7)	Male	39	4.128	1.005	0.161		
with						-0.33	0.741 N.S.
2 (of S1)	Male	72	4.181	0.657	0.077		
1 (of p7)	Male	39	4.128	1.005	0.161		
with						-2.26	0.026*
3 (of S2)	Male	72	4.833	1.800	0.212		

2 (of S1) with	Male	72	4.181	0.657	0.077	-2.89	0.004**
3 (of S2)	Male	72	4.833	1.800	0.212		

<u>Problem 10</u>

1 (of P7) with	Female	39	4.923	1.345	0.215	12.51	0.015**
2 (of S1)	Female	24	4.042	1.367	0.279		
1 (of P7) with	Female	39	4.923	1.345	0.215	-0.24	0.815 N.S.
3 (of S2)	Female	24	5.000	1.063	0.217		
2 (of S1) with	Female	24	4.042	1.367	0.279	-2.71	0.009**
3 (of S2)	Female	24	5.000	1.063	0.217		
1 (of P7) with	Male	39	4.515	1.745	0.279	-1.39	0.168 N.S.
2 (of S1)	Male	72	4.889	1.108	0.131		
1 (of P7) with	Male	39	4.513	1.745	0.279	-2.44	0.016*
3 (of S2)	Male	72	5.236	1.337	0.158		
2 (of S1) with	Male	72	4.889	1.108	0.131	-1.70	0.09 N.S.
3 (of S2)	Male	72	5.236	1.337	0.158		

Problem 11

1 (of P7) with	Female	39	3.410	1.956	0.313	0.94	0.350 N.S.
2 (of S1)	Female	24	2.958	1.654	0.338		
1 (of P7) with	Female	39	3.410	1.956	0.313	-1.42	0.161 N.S.
3 (of S2)	Female	24	4.125	1.918	0.392		
2 (of S1) with	Female	24	2.958	1.654	0.338	-2.26	0.029*
3 (of S2)	Female	24	4.125	1.918	0.392		
1 (of P7) with	Male	39	3.436	1.447	0.232	-3.69	0.000**
2 (of S1)	Male	72	4.556	1.564	0.184		
1 (of P7) with	Male	39	3.436	1.447	0.232	-5.05	0.000**
3 (of S2)	Male	72	5.264	1.993	0.235		
2 (of S1) with	Male	72	4.556	1.564	0.184	-2.37	0.019*
3 (of S2)	Male	72	5.264	1.935	0.235		

Problem 12

1 (of P7) with	Female	39	4.128	1.641	0.263	1.08	0.285 N.S.
2 (of S1)	Female	24	3.708	1.233	0.252		
1 (of P7) with	Female	39	4.128	1.641	0.263	0.64	0.526 N.S.
3 (of S2)	Female	24	3.875	1.329	0.271		

2 (of S1) with	Female	24	3.708	1.233	0.252	-0.45	0.655 N.S.
3 (of S2)	Female	24	3.875	1.329	0.271		
1 (of P7) with	Male	39	4.128	1.720	0.275	1.45	0.151 N.S.
2 (of S1)	Male	72	3.756	1.126	0.133		
1 (of P7) with	Male	39	4.128	1.720	0.275	-2.36	0.020*
3 (of S2)	Male	72	5.097	2.228	0.263		
2 (of S1) with	Male	72	3.756	1.126	0.133	-4.63	0.000**
3 (of S2)	Male	72	5.097	2.228	0.263		

<u>Total Problems</u>

1 (of P7) with	Female	39	38.692	7.438	1.191	1.12	0.265 N.S.
2 (of S1)	Female	24	36.583	6.871	1.403		
1 (of P7) with	Female	39	38.692	7.438	1.191	-1.95	0.056 N.S.
3 (of S2)	Female	24	42.250	6.299	1.286		
2 (of S1) with	Female	39	36.582	6.871	1.403	-2.98	0.005**
3 (of S2)	Female	24	42.250	6.299	1.286		
1 (of P7) with	Male	39	39.103	7.387	1.183	-2.68	0.008**
2 (of S1)	Male	72	43.083	7.513	0.885		

1 (of E7) with	Male	39	39.103	7.387	1.183	-6.71	0.000**
5 (of E2)	Male	72	48.250	6.560	0.772		
2 (of E1) with	Male	72	43.085	7.513	0.885	-4.40	0.000**
5 (of E2)	Male	72	48.250	6.560	0.773		

* Statistically significant

** Statistically highly significant

N.S. Not significant

The Results

Table 5.12 shows the comparative grade groups of females and males. Levels of significance of mean score differences on each of the twelve schemes of thought problems, including those of the total problems are also shown. A summary of the results is appended below, in table 5.13.

Table 5.13

Showing the Number of Cases of Levels of Significance of Mean Differences on Twelve Schemes of Thought Problems, and the Total of the Problems

S. No.	Schemes of thought & problem number	Number of cases		
		Not significant	Statistically significant	Statistically highly significant
1.	Conservation of Volume (Prob-1)	4	2	-
2.	Using Common Differences(Prob-2)	4	-	2
3.	Combinatorial Analysis (Prob-3)	3	2	1
4.	Observation Perspective (Prob-4)	3	1	2
5.	Seriation (Prob-5)	3	1	2
6.	Classification (Prob-6)	1	3	2
7.	Proportionality (Prob-7)	4	1	1
8.	Stating Hypothesis (Prob-8)	2	1	3

9.	Probabilistic Reasoning (Prob-9)	4	1	2
10.	Insightful figural Knowledge (Prob-10)	3	1	2
11.	Grasping Essence of Problem (Prob-11)	2	2	2
12.	Generalised Logical Thought (Prob-12)	4	1	1
	Aggregate*	2	-	4

*Are not the sum of the figures from above but the significance levels of the Total Problems' scores.

It was found that, except for two problems, on the average there existed statistically highly significant differences, in performance scores of females and males of Ugandan pupils studying in the three grade groups (P7; S1 and S2), tested on twelve schemes of thought problems. Accordingly the null hypothesis was accepted with regard to the problems recording no significant differences but rejected in the cases of highly significant differences. Discussions and interpretations of the results were made jointly with that of hypothesis-3.

Interpretation and Discussions o
the Results of Hypotheses 3 & 4

The two hypotheses aimed at identifying stages of the subjects' Piagetian Logical Operations. According to the results and interpretations of the first two hypotheses, incidence of evidence for the subjects functioning at

either of the two cognitive, developmental stages were indicated without clear specifications of which one of the grade, age or sex groups functioned at either concrete or formal stages.

Distinguishing characteristics between concrete and formal operational thinkers have been made by various researchers as existing, in various forms. In his life-long studies, Piaget found the concrete and formal operational thinkers, aged within the range of (12-15) years. He found that, the thinkers of the two stages differed significantly in task performance scores, with formal operational thinkers, found scoring higher than the concrete operational thinkers.

Bantista (1975) confirmed the Piagetian suppositions to the extend that formal operational thinkers performed significantly better than concrete operational thinkers. Sayre and Ball (1975) found subjects of both Junior and Senior High Schools functioning at formal operational level, although the ability to function at formal operations level grew, from grade to grade. Enewine (1976) found significant differences existing at formal reasoning ability between subjects of more and less content areas, but no significant differences existed between formal reasoning ability and sex. Rowell and Hoffman (1975) found formal thinking increased more with chronological age, and that there were more formal operational thinkers among upper stream (high ability) subjects than in the lower stream (low ability) subjects.

White (1975) found Science Major Subjects pupils significantly more formal operational than the Non-Science Major Subjects pupils. Jennifer (1983) found concrete operational structures consisted of Multiplicative Classification and Multiplicative Seriation, while formal operational structures consisted of Combinatorial System of INRC Group, and Binary Operation. The results revealed the formation of a unidimensional scale of increasing difficulty for the tasks, in the following order: Multiplicative Seriation - Multiplicative Classification - Combinatorial System of INRC Group - Binary Operation. Crenshaw (1983) found no significant differences existed between subjects' levels of cognitive development and a teaching method. It was however found that formal operational subjects significantly out-performed concrete operational subjects. Watson (1984) found cognitive scores of two groups of subjects did not differ significantly at the Freshman level, but the cognitive scores of Science Group were significantly higher than that of Humanities Group.

The cited distinguishing characteristics for concrete, as well as, formal operational stages have indicated areas of similarities and dissimilarities with reference to the results of hypotheses 3 and 4. In hypothesis-3 the results revealed significant differences existing agewise between the three grade groups of the

subjects in nearly all, but four schemes of thought problems. The four schemes of thought problems (Prob-1, Prob-2, Prob-11 and Prob-12) showed significant differences existing between age groups of Senior One and Senior Two grade groups on Problems 1 and 2; and between the age groups of the Primary Seven grade on Problems 11 and 12. In hypothesis-4 significant differences were shown existing between the grade groups, sexwise. Incidences of higher grades (of S2) performing better than the primary (P7) or middle (S1) grades were also revealed in the Descriptive Data Analysis, whereby mean performances scores on twelve schemes of thought problems were shown better performed by higher grade (of Senior 2) than by the Primary grade (P7) or the middle grade (S1). Thus, gradewise, sufficient evidence exists to support an interpretation to the effect that regardless of age and sex, more concrete operational thinkers belonged to lower grades (Primary Seven and Senior One), while the higher grade (S2) formed more of the group of formal operational thinkers.

Results and Discussions of Hypotheses 5 and 6

Hypothesis-5

> There are no significant differences existing among performance scores of Ugandan pupils of "Peasant fathers and housewife mothers", and "Others" tested on each of twelve schemes of thought problems.

Procedure

The statistics required for testing the hypothesis was computerized using mean scores of group specifications of subjects whose fathers were peasants, and mothers, housewives, compared subjects of "others" parents. The group of "others" encompassed subjects whose fathers could have been peasants, but mothers were not housewives; or whose mothers could have been housewives, but fathers were not peasants.

Table 5.14 shows the number of cases belonging to each group. Details of the statistics used in testing the hypothesis are also indicated in table 5.14.

Contd.

Table 5.14

Showing the Number of Cases of Pupils of "Peasant-housewife" Parentage Compared with pupils of "Others", and the Distribution of the Statistics of Twelve Schemes of Thought Problems

Problem Number	Groups compared	Number of cases	Mean Values	S.D. values	S.E. Values	't' Values	2-Tail Probability Estimates
Prob-1	1 (of Peasant fathers & Housewife mothers) with	165	6.352	1.521	0.118	-1.47	0.142 N.S.
	2 (of Others)	105	6.638	1.618	0.158		
Prob-2	1 (of Peasant fathers & Housewife mothers) with	165	4.146	1.078	0.084	0.90	0.370 N.S.
	2 (of Others)	105	4.109	1.201	0.117		
Prob-3	1 (of Peasant fathers & Housewife mothers) with	165	3.339	1.187	0.092	0.60	0.547 N.S.
	2 (of Others)	105	3.248	1.269	0.124		
Prob-4	1 (of Peasant fathers & Housewife mothers) with	165	1.824	0.680	0.053	2.74	0.007**
	2 (of Others)	105	1.600	0.614	0.060		
Prob-5	1 (of Peasant fathers & Housewife mothers) with	165	2.970	0.990	0.077	-1.21	0.227 N.S.
	2 (of Others)	105	3.124	1.062	0.104		
Prob-6	1 (of Peasant fathers & Housewife mothers) with	165	2.333	1.398	0.109	0.39	0.698 N.S.
	2 (of Others)	105	2.267	1.332	0.130		

Prob-7	1 (of Peasant fathers & Housewife mothers) with	165	1.061	0.763	0.059	0.03	0.372 N.S.
	2 (of Others)	105	1.057	0.842	0.082		
Prob-8	1 (of Peasant fathers & Housewife mothers) with	165	5.249	0.940	0.073	1.88	0.061 N.S.
	2 (of Others)	105	5.020	1.028	0.100		
Prob-9	1 (of Peasant fathers & Housewife mothers) with	165	4.346	1.208	0.094	1.32	0.189 N.S.
	2 (of Others)	105	4.152	1.116	0.109		
Prob-10	1 (of Peasant fathers & Housewife mothers) with	165	4.958	1.359	0.106	1.38	0.170 N.S.
	2 (of Others)	105	4.724	1.362	0.133		
Prob-11	1 (of Peasant fathers & Housewife mothers) with	165	4.376	1.980	0.154	1.48	0.139 N.S.
	2 (of Others)	105					
Prob-12	1 (of Peasant fathers & Housewife mothers) with	165	4.236	1.728	0.135	0.17	0.867 N.S.
	2 (of Others)	105	4.200	1.767	0.172		
Total Probs.	1 (of Peasant fathers & Housewife mothers) with	165	43.103	7.973	0.621	1.29	0.199 N.S.
	2 (of Others)	105	41.810	8.183	0.799		

* Statistically significant
** Statistically highly significant
N.S. Not significant

The Results

Table 5.14 shows the comparative groups along with the levels of significance of mean differences on each of the twelve schemes of thought problems. The resultant levels of significance are shown in table 5.15.

Table 5.15

Showing Results of Levels of Significance of Mean Score Differences in Each of the Twelve Schemes of Thought Problems

S. No.	Schemes of thought (& problems)	Levels of significance: not significant	Statistically significant	Statistically highly significant
1.	Conservation of volume (Prob-1)	1	-	-
2.	Using Common Differences(Prob-2)	1	-	-
3.	Combinatorial Analysis (Prob-3)	1	-	-
4.	Observation Perspective (Prob-4)	-	-	1
5.	Seriation (Prob-5)	1	-	-
6.	Classification(Prob-6)	1	-	-
7.	Proportionality(Prob-7)	1	-	-
8.	Stating Hypotheses (Prob-8)	1	-	-
9.	Probabilistic Reasoning (Prob-9)	1	-	-
10.	Insightful figural knowledge (Prob-10)	1	-	-
11.	Grasping Essence of Problem (Prob-11)	1	-	-
12.	Generalized Logical Thought (Prob-12)	1	-	-
	Aggregate*	11	-	1

*Are not the sum of the figures from above but the significance levels of the total problems' scores.

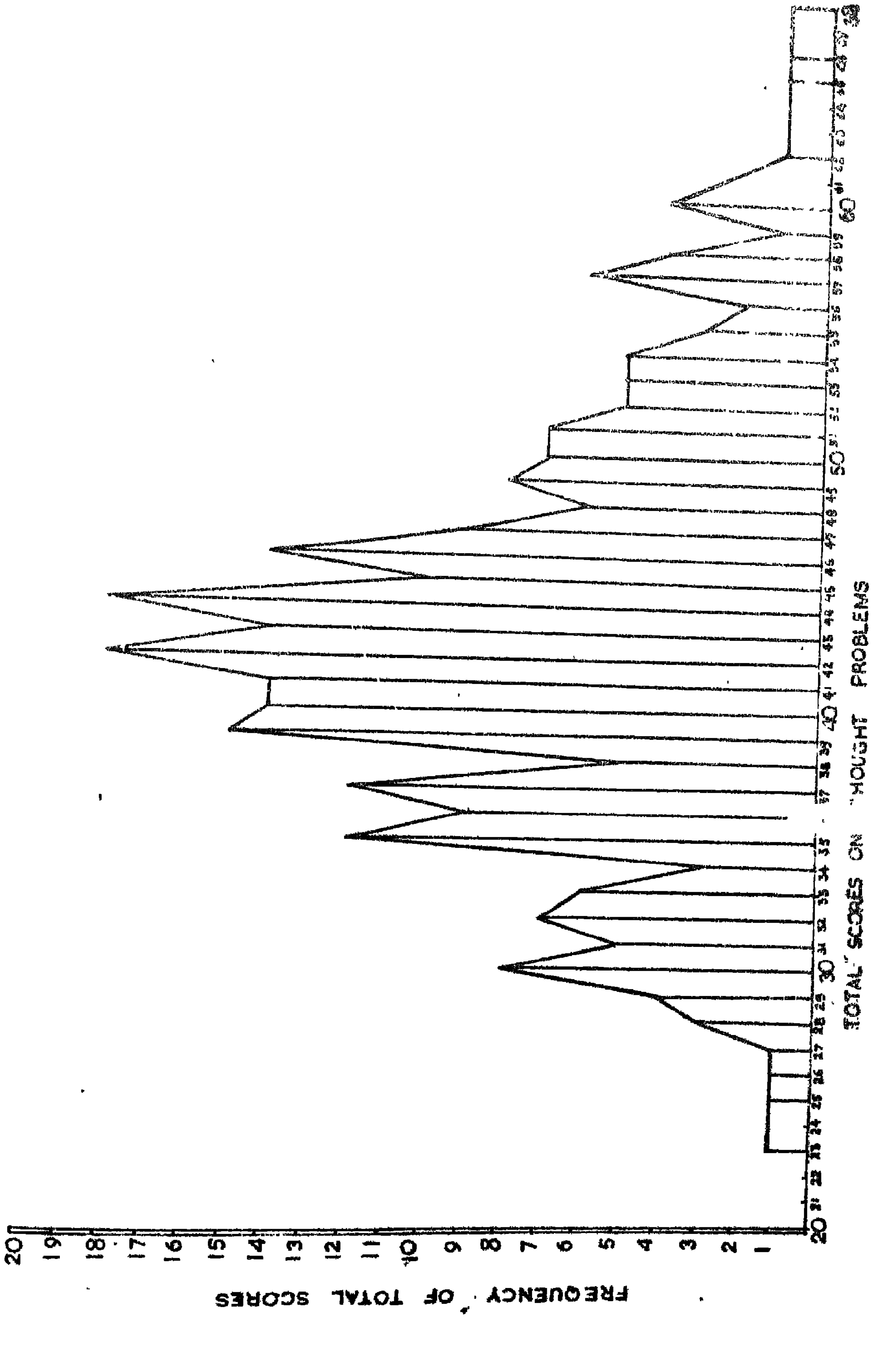
According to the results shown in table 5.15 eleven "Notsignificant differences" were indicated and one statistically/highly significant difference are shown. The hypothesis was accordingly accepted, with regards to elevel schemes of thought problems, but rejected in the case of one. Discussions and interpretations of the results were undertaken jointly with that of hypothesis 6.

Hypothesis-6

> There are no significant differences existing between successful and unsuccessful Ugandan solvers of twelve schemes of thought problems.

Procedure

Difference significance of mean performance scores of 27 percent upper, and 27 percent lower groups, of the sampled subjects were found. Traditionally, 27 percent upper scores of a class is obtained by higher-ability-group students, while 27 percent lower scores of a class are obtained by low-ability-group students of a class. In arranging the total performance scores in an ascending order, it was possible to test the mean differences of the total scores, of 27 percent upper group subjects, with those of 27 percent lower group subjects. Figure 5.1 shows the diagramatic representation of the total scores (scaled along the X-axis) arranged in an increasing order, and of the number of cases of frequencies, of the totals, scaled


FREQUENCY OF TOTAL SCORES
TOTAL SCORES ON
HOUGHT PROBLEMS
20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
20 30 40 50 60

along the X-axis. Forty one (41) cases, in all were involved in the calculation of the statistics used in testing the hypothesis. Table 5.16 shows the distribution of the statistics used, in which the statistics of the 27% upper were matched with that of the 27% lower. A critical ratio was computed, using the formula :

$$CR = \frac{M_U - M_L}{SE}$$

in which,

CR - represents the critical ratio needed for the hypothesis testing;

M_U - represents the mean of the total scores of the 27 percent upper group;

M_L - represents the mean of the total scores of the 27 percent lower group;

SE - represents the standard error of the two standard deviations.

The CR computed was found to be 1.114. It was measured off along the base line of the sampling distribution of differences (as shown in figure 5.2). The critical ratio of 1.114 fell on the base line, to the right of the mean of 0, as well as at - 1.114, to the left of the mean of 0. The table of areas under Normal Probability Curve checked for the CR of 1.114 was found tobe 36.7 percent, and when taken on both sides gave, the value of 73.4 percent. Indicating a total of 26.6 percent of cases for the mean difference to have fallen outside the given limits. Thus, under the null hypothesis CR's as large or larger than ±1.114 occured by chance.

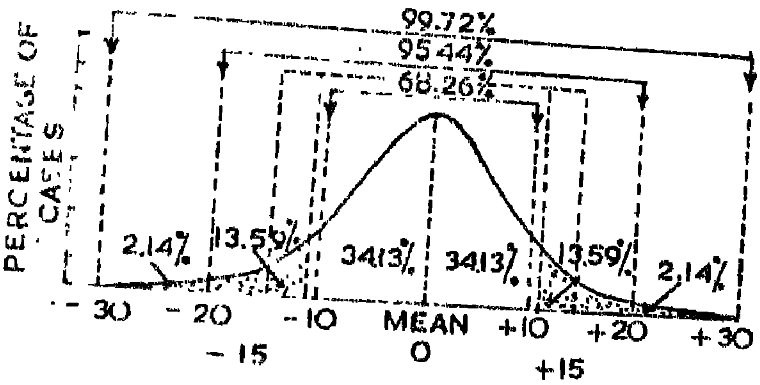
TABLE 5.16

SHOWING NUMBER OF THE CASES OF EACH OF THE 27 PERCENT GROUPS AND DISTRIBUTION OF THE STATISTICS FOR TESTING THE HYPOTHESIS

27 PERCENT GROUP	NUMBER OF CASES	MEAN	S.D.	S.E.	C R
UPPER	11	147.14	73.14		
LOWER	11	110.91	79 30	32.53	1.114

FIGURE 5.2

SHOWING CUTOFF 26.6 PERCENT CASES OF CHANCE ERRORS OUTSIDE GIVEN LIMITS



MEAN DIFFERENCE :

$$\begin{array}{r} 147.14 \\ -110.91 \\ \hline 36.23 \end{array}$$

$$CR = \frac{36.23}{32.53} = 1.1137 = 1.114$$

$$SE = \sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}$$

$$= \sqrt{\frac{5349.46}{11} + \frac{6288.49}{11}}$$

$$= \sqrt{486.31 + 571.68}$$

$$= \sqrt{1057.99}$$

$$= 32.53$$

Interpretation and Discussions of the Results of Hypotheses 5 and 6

By the two hypotheses, an attempt was made to establish aspects of adolescent's logical thought with reference to relationships of high or low performance scores and variations, due to socialization. Hypothesis-5 aimed at associating the subjects performance scores with certain characteristic, adolescent logical thinking vis-a-vis some social environmental variations. The subjects belonged to categories of parents, who were both peasants and housewives and, others, who were professionals, managers, business-persons, or holding other public offices. Hypothesis-6 aimed at dividing the subjects into groups of high ability and low ability achievers in order to infer incidence of concrete and formal operational thinking. Subjects' positions on the increasing or decreasing total scores on twelve schemes of thought problems were considered. The scores belonged to 27 percent upper; and 27 percent lower totals.

Misra (1973) found no significant differences existing between 27% top and bottom group, subjects tested. Kansakar (1979) found top 25 percent and bottom 25 percent of the subjects differed in age and grade; but not in intelligence. In the results of Hypothesis-6 no significant differences were shown existed between total performance scores of the 27 percent upper and 27 percent lower groups. But the results of Hypothesis-5 showed significant differences existing on a majority basis, between the two groups

compared, and in the results of Descriptive Data Analysis, more higher mean performance scores were found favoured, subjects whose parents were both peasants and housewives. Steward (1947) found men who dealt with words and mathematical symbols, as part of their regular business, scored, highly in 'AGCT Scores', of Army Personnel Groups by Occupation, and the groups who worked with their hands scored the lowest. Similarly, in his M.Ed. Dissertation (1977), the investigator found 37.6 percent (highest), of the subjects failing in Mathematics at Secondary Examination had unemployed parents. In a study on epistemological hierarchy, Royce (1964) found Chemistry-Biology subjects dominantly metaphoristic; and Maths-Theoretical Physical subjects, dominantly rationalistic.

There is, therefore, ample evidence to interpret the results of the two hypotheses 5 and 6, as being independent of the typology, of parental occupations, as well as, of total performance scores, of schemes of thought problem. Hence, incidence of socialisation, favouring successful performance on schemes of adolescent thought is, restrictive.

CHAPTER VI

FACTOR ANALYSIS AND INTERPRETATION TESTING HYPOTHESIS 7

CHAPTER VI

FACTOR ANALYSIS AND INTERPRETATION : TESTING OF HYPOTHESIS-7

Determination of Common Factors

Spearman (1904) sought to show the correlations among a set of tests of scholastic achievement and of cognition, which could be accounted for by a single common factor, he called 'g' (or general intelligence). The work was based on the hypothesis that each test of intellectual functioning would contain a common 'g', common to all such tests and a specific component, unique to each. His conception and work, coupled with attempts made by British Psychologists, in 1930's to develop methods for the discovery of common intellectual factors, led to the establishment of the hypothesis about factor structure compositions of observed variables. According to the conceptions, intellect consists of numerous abilities whose relative importance depends on their place in a hierarchy of abilities. At the peak of this hierarchy is, general intelligence which, it was believed, is involved in most intellectual activities. Below the peak, were believed to be, general abilities such as: Verbal/academic ability and spatial/mechanical ability,

each of which was said to influence broad domains intellectual functioning. At the bottom of the hi were believed to be, specific abilities found only individual tests (Vernon, 1961). Thurstone (in th of the 1930s) rejected, the British view of the in being hierarchically structured, with general inte at the top. According to him, the intellect consi number of primary mental abilities that combine to the varied forms of cognitive functioning. Thurst led to postulate the idea of a single structure th every primary mental ability is found in any given of cognitive functioning, so as to discover the pr mental abilities. He implemented the concept math using the procedure of factor rotation, which inve formation of initial solutions for unobserved comm in a principal factor solution that tended to all factor with a distinct cluster of highly similar t

Factor analytic techniques are now commonl both psychologists and educationists engaging in c research works. Until recently cognitive psychol interested themselves, mainly in describing the pr used by the individual in problem solving, and di psychologists, using factor analysis, concerned th primarily with, discovering ways in which individu in their problem solving behaviour. Cognitive ps approached their subject, behaviouristically and

experimentally, whereas factor analytically oriented differential psychologists focused attention on traits, as a conceptual paradigm in emphasising use of correlational method.

Analysis of ideas, and conceptions of analytic approaches to theory building in Science Education are important techniques used to understand thought processes. Hence the role in this study of a factorial analysis of the subjects' performance scores.

Hypothesis-7

> There does not exist any factorial structure of adolescent thought in the twelve schemes of thought problems administered to Ugandan pupils.

Procedure

Task performance scores of the subjects were subjected to factorial analysis using S.P.S.S. Package RAYAL-1022 Computer to obtain inter-correlation coefficients, estimates of communalities, common factors, and factor loadings. The inter-correlation coefficients obtained, for twelve schemes of thought problems were recorded in one-half, symmetrical correlation matrix coefficients as shown in table 6.1. Altogether, 66 correlation coefficients are shown. Their magnitudes ranged between .000 and .449.

Table 6.1

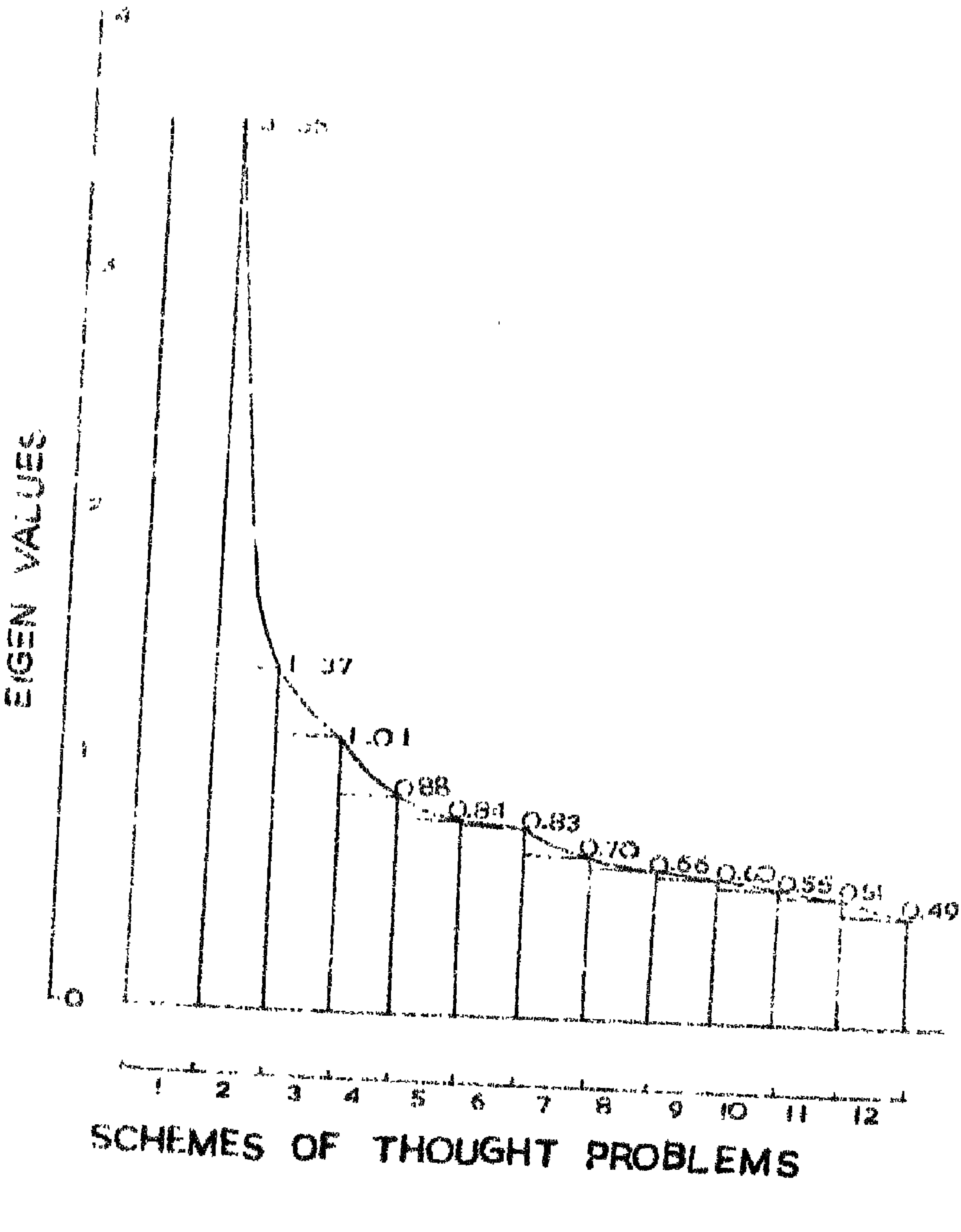
Showing Correlations between Performance Scores on Twelve Schemes of Thought Problems

Name of Scheme of Thought & Problem No.	Prob-1	Prob-2	Prob-3	Prob-4	Prob-5	Prob-6	Prob-7	Prob-8	Prob-9	Prob-10	Prob-11	Prob-12
Conservation of Volume (Prob-1)		0.287	0.248	0.182	0.366	0.369	0.296	0.243	0.229	0.190	0.231	0.286
Using Common Differences (Prob-2)			0.428	0.308	0.198	0.190	0.131	0.174	0.090	0.161	0.206	0.002
Combinatorial Analysis (Prob-3)				0.246	0.238	0.309	0.189	0.271	0.142	0.206	0.213	0.065
Observation Perspective (Prob-4)					0.220	0.260	0.277	0.185	0.073	0.146	0.234	0.007
Seriation (Prob-5)						0.046	0.335	0.219	0.220	0.220	0.249	0.109
Classification(Prob-6)							0.404	0.359	0.292	0.193	0.316	0.160
Proportionality(Prob-7)								0.270	0.359	0.155	0.297	0.141
Stating Hypotheses (Prob-8)									0.214	0.189	0.220	0.064
Probability (Prob-9)										0.132	0.321	0.331
Insightful Knowledge (Prob-10)											0.235	0.152
Grasping Essence of Problem (Prob-11)												0.265
Generalised Logical Thought (Prob-12)												

The correlation coefficients were analyzed, using the method of Maximum Likelihood, to obtain required common factors. Joreskog (1969), strongly recommended use of the method to determine provisional estimates and the exact number of common factors. Lawley (1940) also advocated for the use of such a method. Mathematical statisticians use Diagonal and Centroid Methods of factoring correlation matrices to obtain estimates of: common factors; communalities; and factor loadings. The methods call for different values to be inserted in the Principal Diagonal of Correlation matrices. Most commonly inserted, are the communality values, the reliability coefficients, and the unity (1.0), which represents self-correlation of a test score. For a given set of tests, the usual practice is to hypothesize for at least three tests as the common factors to account for all the set of tests. Eigen Values then confirm the exact number of the common factors possessed in the set. The hypothetical tests(at least three), whose eigen values are equal to, or exceed unity provide the common factors. The diagonal, as well as, centroid methods provide ways for factoring correlation matrices to obtain the desired common factors. The methods are time consuming, but high-speed computer facilities are now days used to carry out the calculations. Table 6.2 shows three common factors thus extracted, along with their eigen-values. Another criteria in use, and which was employed in the study to establish the existence of the exact number of common factors, is of

FIGURE 6.1

SHOWING EIGEN VALUES OF TWELVE SCHEMES OF THOUGHT PROBLEMS.



Cattell's Scree Test. Figure 6.1 shows the point reached, in which the eigen-values started to diminish, in nearly a straight line-fashion after a noticiable drop (at point 3) from the preceding eigen values.

Table 6.2

Showing Three Common Factors for Twelve Schemes of Thought Problems with Eigen Values, greater than Unity

S. No.	Hypothetical Reference/ Common Factors	Eigen Value	Percentage of Schemes' Problems	Cumulative Percentage
*1.	Conservation of Volume (Prob-1)	3.564	29.7	29.7
*2.	Using Common Differences (Prob-2)	1.368	11.4	41.1
*3.	Combinatorial Analysis (Prob-3)	1.010	8.4	49.5
4.	Observation Perspective (Prob-4)	0.878	7.3	56.8
5.	Seriation (Prob-5)	0.839	7.0	63.8
6.	Classification(Prob-6)	0.833	6.9	70.8
7.	Proportionality(Prob-7)	0.697	5.8	76.6
8.	Stating Hypotheses (Prob-8)	0.663	5.5	82.1
9.	Probability (Prob-9)	0.597	5.0	87.1
10.	Insightful Knowledge (Prob-10)	0.551	4.6	91.7
11.	Grasping Essence of Problem (Prob-11)	0.514	4.3	95.9
12.	General or Logical Thought (Prob-12)	0.487	4.1	100.0

* Indicates tests having eigen values greater than unity.

Original and Rotated Factor Loadings of the Study

Factor loadings (or structure values) of observations are solutions of the square roots of common variance. The common variance is defined as that portion of reliable variance which correlates with other variables in the total variance of a test shown in figure 6.2. The square roots, which are of independent factors form the factor loadings that represent the amount of correlation of the problems with each other (Fruchter, 1967).

Figure 6.2

Showing Schematic Representation of Total Variances of Test Scores

Reliable Variance

t_{j1}^2	t_{j2}^2	t_{j3}^2		t_{jr}^2	s_j^2	e_j^2
Common Variance					Specific Variance	Error Variance

The amount of correlation between any two tests is reflected in the common variances that any two or more of them share; the larger the factor loadings, in the two or more tests, the higher is the correlation between the tests. The converse is true. In order to obtain original factor loadings of the twelve schemes of thought problems, correlation matrix (of table 6.1) was subjected to factorial analysis, using Principal Factor (no iteration) Method.

Table 6.3 shows the factor loadings, thus obtained.

Table 6.3

Showing Original Factor Loading Estimates in Three Common Factors along with Communality Estimates

The Schemes and Problem Number	Factor-1	Factor-2	Factor-3	(h^2)
Conservation of Volume (Prob-1)	-0.612	-0.078	-0.162	0.404
Using Common Differences (Prob-2)	-0.478	-0.535	-0.359	0.643
Combinatorial Analysis (Prob-3)	-0.549	-0.405	0.302	0.554
Observation Perspective (Prob-4)	-0.476	-0.383	-0.330	0.374
Seriation (Prob-5)	-0.620	-0.012	-0.303	0.476
Classification(Prob-6)	-0.701	0.050	-0.297	0.582
Proportionality (Prob-7)	-0.617	0.186	-0.355	0.542
Stating Hypotheses (Prob-8)	-0.532	-0.065	-0.157	0.312
Probabilistic Reasoning (Prob-9)	-0.315	0.528	0.038	0.305
Insightful Figural Reasoning (Prob-10)	-0.427	0.004	0.417	0.357
Grasping Essence of Problem (Prob-11)	-0.595	0.224	0.237	0.461
Generalised Logical Thought (Prob-12)	-0.304	0.630	0.447	0.690

The estimated values shown in table 6.3 came from the analysis (solutions) of correlations among twelve schemes of thought problems. Whereas estimates shown on Factor-1 have the characteristics of being highly correlating with almost all estimates in the twelve schemes of

thought problems, estimates of the remaining two common factors (Factors 2 and 3) are related to fewer and fewer other problems. When the estimates were once again subjected to rotational process, using direct oblique rotation more specific factor loadings of Varimax Rotated Factor Matrix (of table 6.4) were obtained.

Table 6.4

Showing Varimax Rotated Factor Matrix Loadings in Three Common Factors

Problem Number	Factor-1	Factor-2	Factor-3
Conservation of Volume (Prob-1)	0.272	0.568	0.100
Using Common Differences (Prob-2)	0.795	0.104	0.002
Combinatorial Analysis (Prob-3)	0.710	0.203	0.095
Observation Perspective (Prob-4)	0.483	0.361	-0.104
Seriation (Prob-5)	0.156	0.668	0.073
Classification (Prob-6)	0.158	0.730	0.155
Proportionality (Prob-7)	-0.008	0.712	0.188
Stating Hypotheses (Prob-8)	0.225	0.504	0.081
Probabilitistic Reasoning (Prob-9)	-0.092	0.402	0.614
Insightful and Figural Knowledge (Prob-10)	0.434	0.061	0.406
Grasping Essence of Problem (Prob-11)	0.272	0.318	0.535
Generalised Logical Thought (Prob-12)	-0.039	-0.015	0.829

Most of the estimates of table 6.4 possess positive signs compared with estimates of original factor loadings (of table 6.3), thus making them appropriate to be used for further interpretational investigations.

Interpretation of Identified Factor Loadings

The process of interpreting content, or saturation, of the twelve schemes of thought problems, of the study started with the identification of the factor loadings possessed by the problems. This was done against the background of doubt, concerning uniform and specific criteria for accepting 'high', factor loadings, and ignoring 'small' loadings. Fruchter (1967) suggested, for factor loadings, less than .200, as being generally insignificant, and hence fit to be ignored. Some other researchers have ignored loadings valued upto, and including .300 and .350. Manju Jain (1984) excluded loadings with values at less than ± .350. This study has used Varimax Rotated, factor loadings with squared estimates valued at least, a tenth portion, of the totality of the problem's estimates of communality. The loadings included those, valued at, and equaling upto ± .300. They were described separately under three common factors, as follows :

(A) : Under Factor 1

Four significant factor loadings were identified, namely, of the schemes of: (1) Using Common Differences

(Problem-2); (2) Combinatorial Analysis (Problem-3); (3) Observation in Coordinate and Perspective Systems (Problem-4); and (4) Insightful and Figural Knowledge (Problem-10). Figure 6.3 shows the diagramatic representation of each of the identified problems, along with their respective factor loadings, which ranged in magnitude, from .400 to .800, and were described possessing high, as well as, moderate, loadings in size. Table 6.5 shows details of proportions of specific, error, and reliable variances, contained in the problems' scores.

<u>Figure 6.3</u>

Showing Four Significant Loadings identified on Common Factor-1

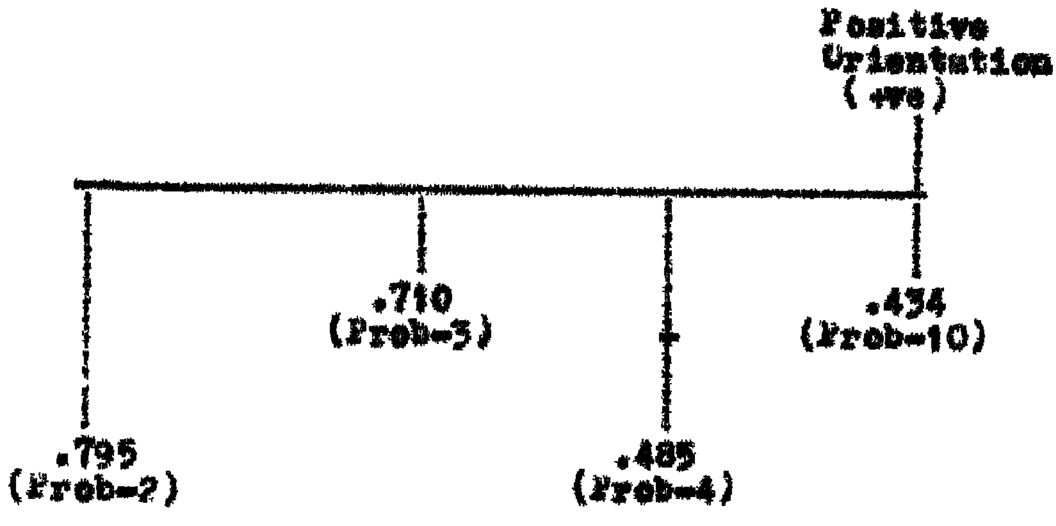


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Table 6.5

Showing Four Significant Loadings identified on Common Factor-1

S. No.	Scheme of Thought & Prob. Number	Factor 1	Factor 2	Factor 3	h^2	s^2	r_{11}
1.	Using Common Differences (Prob-2)	.795*	.104	.002	.65	.04	.69
2.	Combinatorial Analysis(Prob-3)	.710*	.203	.095	.55	.27	.82
3.	Observation Perspective (Prob-4)	.485*	.361	.104	.38	-	.32**
4.	Insightful Figural Knowledge (Prob-1)	.434*	.061	.406	.35	.40	.75

* Indicates factor loadings of the four problems identified significant.

** No estimate, for specific variance for Prob-4 is indicated, as its value of communality estimate exceeds the problem's reliability value, thus making it impossible to estimate a positive value of specific variance.

(b) i Under Factor-2

Eight significant loadings were identified. They included the loadings of the schemes of: (1) Problem 1 (of Conservation of Volume); (2) Problem 4 (of Observation in Coordinate and Perspective Systems); (3) Problem 5 (of Seriation); (4) Problem 6 (of Classification); (5) Problem 7 (of Proportionality); (6) Problem 8 (of Stating Hypotheses); (7) Problem 9 (of Probability; and (8) Problem 11 (of Grasping the Essence of Problem).

Figure 6.4 shows the identified problems, alongwith, the estimates of their factor loadings, which ranged from .300 to .800, and described as possessing satisfactory, moderate, and high factors in size. Proportions of their specific, reliable, and error variances are shown in table 6.6.

<u>Figure 6.4</u>

Showing Eight Significant Loadings identified on Common Factor-2

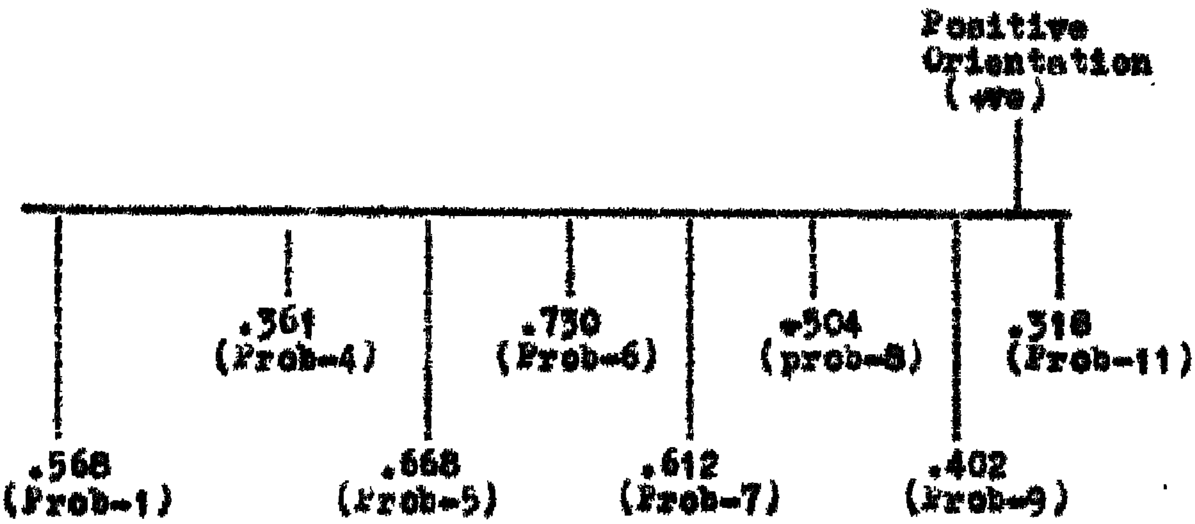

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Table 6.6

Showing Eight Significant Loadings identified on Common Factor-2

Schemes of thought (Prob. Number)	Factor 1	Factor 2	Factor 3	h^2	s^2	r_{11}
Conservation of Volume (Prob-1)	.272	.568*	.100	.40	.37	.77
Observation Perspective (Prob-4)	.485	.361*	.095	.38	-	.32**
Seriation (Prob-5)	.156	.668*	.073	.47	-	.38**
Classification (Prob-6)	.198	.730*	.155	.57	.16	.73
Proportionality (Prob-7)	.008	.712*	.188	.55	-	.53**
Stating Hypotheses (Prob-8)	.225	.504*	.091	.30	.27	.57
Probabilistic Reasoning(Prob-9)	.082	.402*	.614	.54	.27	.81
Grasping Essence of Problem(Prob-11)	.272	.318*	.535	.46	.17	.63

* Indicates eight significant factor loadings identified on Factor-2

** Indicates three problems whose communality estimates exceed the reliability estimates making it difficult to compute positive values of their specific variances.

(C) : Under Factor-3

Four problems with significant loadings were identified. They included the loadings of the schemes of : (1) Problem 9 (of Probability); (2) Problem 10 (of Insightful and Figural Knowledge); (3) Problem 11 (of Grasping Essence

of Problem); and (4) Problem 12 (of Generalised Logical Thought.

Figure 6.5 shows the schematic representation of the problems, along with their respective loadings. Magnitudes of the loadings ranged from .400 to .850 which were described as fair, moderate, moderately high and high in size. Details of their proportions of the specific reliable and error variances are shown in table 6.5.

<u>Figure 6.5</u>

Showing Four Significant Loadings identified on Common Factor -3

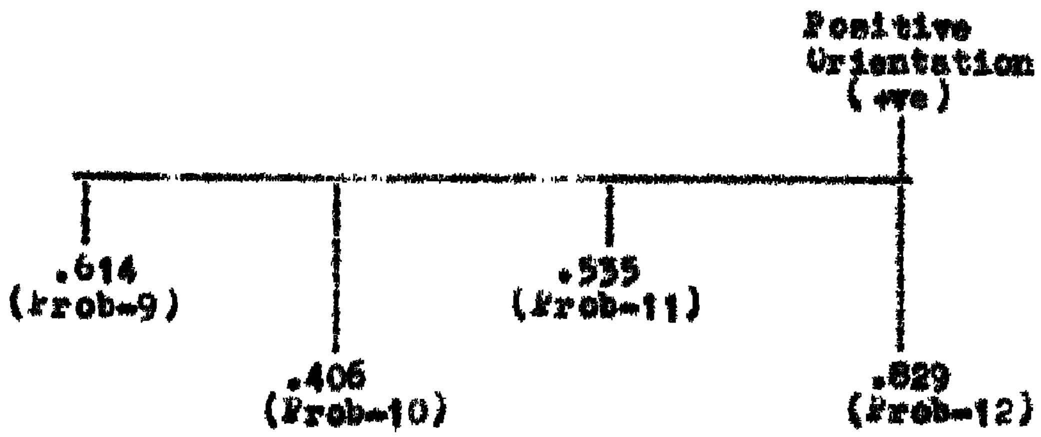

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Table 6.7

Showing Four Significant Loadings identified on Common Factor -3

Scheme of thought	Factor	Factor	Factor	h^2	S^2	r_{11}
Probability Reasoning (Prob-9)	-.082	.402	.614*	.54	.27	.81
Insightful and Figural Knowledge (Prob-10)	.434	.061	.406*	.3[illegible]	.40	.75
Grasping Essence of Problem(Prob-11)	.272	.318	.535*	.46	.17	.63
Generalised Logical Thought (Prob-12)	-.039	-.015	.829*	.69	.11	.80

* Indicates four significant factor loadings identified on Factor-3

Factorial Description of Twelve Scheme of Thought

A study of factorial content of twelve schemes of thought was made by defining and describing, empirically, factorial variance proportions forming the schemes performance scores, which were subjected to factorial analysis, using factor loadings on three common factors. Table 6.8 shows Cluster Analysis, by correlation coefficients, of the twelve schemes. Details of their other factorial contents is shown in table 6.9.

Table 6.8

Showing Cluster Analysis by Correlation Coefficients listed in Order of Size of Performance Scores on Twelve Schemes of Thought

Twelve schemes of thought	The Problem Numbers	0.000 0.049	0.050 0.099	0.100 0.149	0.150 0.199	0.200 0.249	0.250 0.299	0.300* 0.349	0.350* 0.399	0.400* 0.449
Conservation of volume	(Prob-1)		12		4,10	8,9	2,3,7		5,6	
Using common Difference	(Prob-2)	12		7	5,6,8 10	11	1,9	4		3
Combinatorial Analysis	(Prob-3)		12	9	7,10	1,4,5	8	6		2
Observation	(Prob-4)	12	9	10	1,8	5,3, 11	6,7	2		
Seriation	(Prob-5)			12	2	3,4,8 9,10, 11		7	1	6
Classification	(Prob-6)				2,10 12		9,4	3,11	1,8	5,7
Proportionality	(Prob-7)			2,12	3,10		1,4,8	5	9	6
Stating Hypotheses	(Prob-8)		12		2,4, 10	1,5,9 11	7,3		6	
Probability	(Prob-9)		4,2	3,10		1,5,8	6	11,12	7	
Insightful and figural knowledge	(Prob-10)			4,9	1,2,7 8,12	3,5,11				
Grasping Essence of Problem	(Prob-11)					2,3,4 5,8,10	1,7, 10,12	6,9		
Generalised Logical Thought	(Prob-12)	2,4	1,3,8	5,7	10,6		11	9		

* Indicates columns of appreciably correlated set of problems which measure, like aspects of logical thought.

Table 6.9

Showing Overall Picture of Factor-Analytic Description of Twelve Schemes of Thought listed in Hierarchical Order of Achievement Performance

Scheme of Thought and Problem Numbers	Hierarchical Performance Order	r_{11}	h^2	$**U^2$	S^2	e^2	Cocorrelates
Combinatorial Analysis (Prob-3)	1st	.82	.55	.45	.27	.18	6 and 2
Using Common Difference (Prob-2)	2nd	.69	.65	.35	.04	.31	4 and 3
Conservation of Volume (Prob-1)	3rd	.77	.40	.60	.37	.23	5 and 6
Insightful and Figural Knowledge (Prob-10)	4th	.75	.35	.65	.40	.25	Nil
*Classification (Prob-6)	5th	.73	.57	.43	.16	.28	3,11,1,6, 5 & 7
*Seriation (Prob-5)	6th	.35	.47	.53	- 12	65	1 and 5
Stating Hypotheses (Prob-8)	7th	.57	.30	.70	.27	.43	6
*Observation in Coordinate & Perspective Systems (Prob-4)	8th	.32	.38	.62	- 6	68	2
Probability & Chance Occurence (Prob-9)	9th	.81	.54	.46	.27	.19	11,12 & 7
Generalised Logical Thought (Prob-12)	10th	.80	.69	.31	.11	.20	9
Grasping Essence of Problem (Prob-11)	11th	.63	.46	.54	.17	.37	6 and 9
*Proportionality (Prob-7)	12th	.53	.55	.45	- 2	47	5,9 and 6

* Indicates problems whose communality values exceeded reliability coefficients. They were dropped from further factorial analysis as their specific variances were found possessing negative variance estimates.

** Indicates the uniqueness estimates of the problem scores. The relationships between the uniqueness of a problem score with its communality estimate is expressed by the formula: $u^2 = 1 - h^2$

Problem 1 : (On Scheme of Conservation of Volume)

Piaget defines conservation as a logical scheme of operations by means of which subjects maintain magnitudes and relations, despite displacements and perceptual transforms of all sorts. By it is, implied, a fixed system of reference, independent to a large extent of perceptual, representational, and linguistic information. It is believed deeply rooted in the subjects awareness of his/her own actions. In setting the problem, it was planned to test all those characteristics, and identity subjects' capabilities and incapabilities on such tasks which concern levels, amounts, and volumes of liquid, represented in variously shaped containers. Factorially, it is shown possessing an appreciably high loading (of .563) and highly correlated with Problems 5 and 6 (as shown in tables 6.8 and 6.9), indicating that it measures like aspects of logical thought with the two problems. Its communality estimate (of .40) indicates of its common variance, as being far short of its reliability coefficient (of .77). Thus a considerable amount of its reliable variance has not been accounted for. Its specific variance is .37 and an error variance is .23. Its performance value achievement hierarchy order, ranks it the third best out of twelve.

Problem 2 : (On scheme of Using Common Differences)

Piaget and Szeminska (1941) investigate issues connected with elementary operations of correspondence,

equating, etc. that constitute the logic of number and its additive and multiplicative properties. The study also investigates subjects' capabilities over operations consisting of numerical figures and patterns. In setting the problem it was planned to test the mastery of the subjects over patterns of numbers involving the subjects' application of knowledge of additive and subtractive properties of numerals. Factorially, it has shown insignificant loadings, and is shown correlated fairly and appreciably with problems 4 and 3 (as shown in tables 6.8 and 6.9). Its communality estimate (of .65) indicates of its reliable variance, as being wholly, a common factor variance. Its reliability coefficient (of .69) shows that its reliable variance has been satisfactorily accounted for, thus leaving it with a low specific variance (of .04). It possesses a fairly high error variance (of .31). Its performance value achievement hierarchy order ranks it the second best achieved of the twelve schemes.

Problem 5 : (On scheme of Combinatorial Analysis)

The scheme of Combinatorial Analysis tests subjects' abilities in cases of proportion, of the type : given p and q that can be neither true nor false, which subjects could group into four, as follows : (1) both true; (2) both false; (3) p- true q- false; and (4) p-false, and q- true, and leading to subjects' mastery of additive and multiplicative class relations. These abilities were intended for testing

in setting the problem. Factorially, it is shown devoid of significant loadings, but has correlated highly with problems 6 and 2, (as shown in tables 6.8 and 6.9). Its communality estimate (of .55) was far short of its reliability coefficient (of .82), indicating that a considerable proportion of its reliable variance has not been accounted for. It has a fairly moderate specific variance (of .27) and an error variance (of .18). Its performance value of achievement hierarchy order ranks the best of all achieved.

<u>Problem 4 : ((On schema of Observation Structuring)</u>

Piaget (1948) studies concrete and formal operations involving coordination of different points of view of observers looking at the same objects from different perspectives, and defines a perspective system as one that entails subjects relating objects, to their own view points, of which they are conscious. To be conscious of one's own view point to Piaget involves distinguishing it from other view points, and by the same token, structuring, and coordinating them. The present proolem was therefore set to test mastery of the subjects ability to structure and coordinate figural patterns abstractly. Factorially, it possesses fairly moderate loadings. It was found difficult to interpret its factorial content, because of its communality estimate (of .38) which exceeded its reliability coefficient (of .32). Such an anomaly would not have been expected from a theoretical

consideration, thus indicating influence of chance errors and uncontrolled processes encountered during the data collection exercise. Aspects of its logicalness of thought have been measured by problem 2, with which it has appreciably correlated (as shown in tables 6.8 and 6.9). Its performance value achievement hierarchy order ranks it the eighth of twelve schemes.

Problem 5 : (On schema of Seriation)

Seriation is defined by Inhelder and Piaget (1959) as an aspect of the logic of relations which refers to arranging of a collection of things systematically, with regard to some dimension along which they differ, say : in order of size, weight or of any desirability. In setting the present problem, it was planned to test the subjects' mastery of the concept with regards to order and weight. Factorially it is shown possessing fairly high loading, and being correlated, appreciably high with Problems 1 and 6 (as shown in tables 6.8 and 6.9). Its communality estimate (of .47) was found exceeding its reliability coefficient (of .38). Such an anomaly would not be expected from a theoretical consideration, thus indicating influence of chance errors and uncontrolled processes to have been underestimated. Aspects of its logicalness of thought have been measured in terms of performance scores of problems: 7, 1 & 6. Its performance value of achievement hierarchy order ranks the sixth.

roblem 6 : (Scheme of Classification)

Inhelder and Piaget (1959) defines classification s the fundamental act of the logic of classes, meaning the ystematically putting together of objects, that belong ogether, on the ground that they share the same property or roperties. In setting the problem it was intended to test ubjects' mastery of the concept through characteristics of btained performance scores. Factorially it is shown ossessing an appreciably high loading (of .730), and ossessing fair , moderate, and fairly moderate correlations ith Problems : 1, 8, 5 and 7 (as shown in tables 6.8 and 6.9). ts communality estimate (of .57) is short of its reliability coefficient (of .73), indicating that a considerable amount f its reliable variance has not been accounted for, thus aking it possess a low specific variance (of .16). Its erformance value achievement hierarachy order ranks it the ifth.

roblem 7 : (On scheme of Proportionality)

Piaget (1952) studies experiments involving formal perational schemata related to proportions dealing with otion, geometrical relations, proportions between weights, nd distances, on the two arms of a balance; and of shadows. he study found understanding of proportions starts, at a ater age (after 11-12 or 13-14 years). In setting the resent problem an attempt was, therefore, made to test the

subjects abilities and to verify the Piagetian assumptions. Factorially, the problem possessed a high loading. It correlated fairly and highly with problems: 5, 9 and 6 (as shown in tables 6.8 and 6.9). Its communality estimate (of .55) was found exceeded its reliability coefficient (of .53). Such an anomaly would not be expected from a theoretical consideration, thus indicating influences of chance errors and uncontrolled processes occuring during the data collection exercise. Its performance value achievement hierarchical order ranks it least of them all achieved.

<u>Problem 8 : (On schema of Stating Hypotheses)</u>

Inhelder and Piaget (1959) studies cases involving equality between action and reaction, the study of chances which are relevant to formal thought and having the property of dealing with what is possible, as well as, what is real. In setting the problem, it was hoped to test the subjects' ability in the understanding of a probability estimate, and stating of hypotheses of relations connected with operational skills and determine the results of the actions. Factorially the problem was shown possessing appreciably fair loadings, and correlated, highly with problem 6 (as shown in tables 6.8 and 6.9). Its communality estimate (of .30) is far short of its reliability coefficient (of .57), indicating that a considerable proportion of its reliable variance has not been accounted for. It has a fairly large size of specific

varience (of .27), and a moderately high error varience (of .143). Its performance value achievement, hierarchical order ranks it the seventh.

Problem 9 : (On scheme of Probability & Chance Occurance)

Piaget and Inhelder (1959) studies subjects' reaction to chance occurences, as well as, how subjects assimilate occurences to systems of deducible, indirectly, through the scheme of probability. In setting the present problem, it was aimed to test the subjects mastery over the tasks of isolating laws of causes of occurences under study, and to fit a probability law to the occurences. Factorially, the problem was shown possessing a fair loading and correlated fairly and highly with problems' 11, 12 and 7 (as shown in tables 6.8 and 6.9). Its communality estimate (of .54) presents a discrepency of relation with its reliability coefficient (of .81), thus leaving room for significant loadings on factors isolated in the group with which it is highly correlated. It possesses a fair proportion of specific variance (of .27) but slight error variance (of .19). Its performance value achievement hierarchical order ranks it the ninth.

Problem 10 : (On scheme of Insightful & Figural Knowledge)

Research on Insightful and Figural Knowledge is reported (Vaidya, 1979) historically to have been performed by Gestalt Psychologists for the investigation of thinking relationships among superior university students in Germany.

In setting the present problem, it was hoped to test the subjects' abilities on schemes related to figural knowledge. Factorially, the problem is shown possessing fairly moderate loadings. It has no significant co-correlates, which measure like aspects of logical thought. Its communality estimate (of .35) is far short of its reliability coefficient (of .75), indicating that a considerable proportion of its reliable variance has not been accounted for. It has a markedly high specific variance (of .40). Its performance value achievement hierarchical order ranks it the four best achieved of the twelve schemes.

Problem 11 : (on Scheme of Grasping the Essence of the Problem)

Piaget and Szeminska (1941) studies additive and multiplicative composition of relations, as well as, of qualitative correspondence of classes, leading to the understanding of the subjects' development of numerical multiplication and multiplication of classes. It analyses additive and multiplicative compositions of asymetrical relations in relation to number, aimed at testing the interdependence and deep seated unit of the mechanisms of the problem. In setting the present problem, it was planned to discover the mastery of the subjects in grasping the essence of various types of tasks connected to questions of relations, classes, identity and operations with numerals. Factorially, it is shown possessing fairly moderate loadings and having appreciably

fair degree of correlation with problems: 6 and 9 (as shown in tables 6.8 and 6.9). Its communality estimate (of .46) is far short of its reliability coefficient (of .63), indicating that some portions of its common variance has not been accounted for. Its performance value achievement hierarchical order ranks it the least of all achieved.

Problem 12 : (On scheme of Generalised Logical Thought)

Inhelder and Piaget (1959) studies the scheme of equilibrium in the balance, aimed at analysing the subjects' mastery over generalised schemes of logical thought. The study involves testing of the abilities to equalise weights on both sides of balance, to order serially, the weights, and solving problems of relationships between numerals: 1 and 2. In setting the present problem, emphasis was laid on testing subjects abilities in schemes of generalised logical operations and thought. Factorially, the problem is shown possessing a high loading, and correlated fairly, with problem 9 (as shown in tables 6.8 and 6.9). Its communality estimate (of .69) is far short of its reliability coefficient (of .80), indicating a considerable proportion of its common variance, thus not been unaccounted for. It has a low proportion of specific variance (of .11). Its performance value achievement hierarchical order ranks it the 10th of the twelve schemes.

Relationships and other Aspects existing, between Nine identified Schemes of Thought Problems and Four Psychological Tests

A study of aspects of factorial relationships existing between four psychological tests and nine factor identified schemes of thought problems was made, using the method of Cluster Analysis. Table 6.10 shows an array of the correlation coefficients, in which 78 correlation coefficients are arranged in one-half symmetrical correlation matrix. The coefficients' magnitudes range from 0.000 to 0.462. The highest coefficients existed between performance scores of Raven's Progressive Matrices Test, and Differential Aptitude Sub-test of Verbal Reasoning (as shown in table 6.11).

Correlation coefficients with magnitudes from .300 to .499 were considered for the identification tasks, having special aspects of relationship. Table 6.11 shows such tasks, listed, along with their co-correlates. Thus, it was possible to obtain a list of tasks, starting with Raven's Progressive Matrices Test which is showing correlating with highly, with eight (8) other tasks, measuring like aspects of schemes of thought. The list runs as follows :

1. Raven's Progressive Matrices Test, which correlated, highly with 8 other tasks;

2. Problem 6, which correlated, highly with 7 other tasks;

3. Abstract Reasoning Test, which correlated, highly, with 5 other tasks;

4. Numerical Ability Test, and Problem 11, each of which correlated, highly with 4 other tasks;

5. Problem 3, which correlated, highly with 3 other tasks;

6. Problems: 1, 2, 8 and 9, each of which correlated, highly with 2 other tasks;

7. Problems: 10 and 12, and Verbal Reasoning Test, each of which correlated, highly with only one other task.

Contd.

Table 6.10

Showing Correlations among Four Psychological Tests and Nine Factor Identified Schemes of Thought Problems

Problems (Tasks)	PMT (P)	MAT (M)	ART (A)	VRT (V)	PROB. 1	PROB. 2	PROB. 3	PROB. 6	PROB. 8	PROB. 9	PROB. 10	PROB. 11	PROB. 12
PMT	1.000	.419	.385	.462	.434	.354	.424	.364	.193	.223	.234	.336	.134
MAT		1.000	.341	.234	.207	.159	.165	.435	.218	.238	.155	.353	.144
ART			1.000	.271	.272	.190	.269	.311	.328	.243	.308	.289	.070
VRT				1.000	.190	.129	.238	.204	.007	.110	.140	.115	.075
Prob-1					1.000	.287	.248	.369	.243	.229	.190	.291	.086
Prob-2						1.000	.428	.190	.175	.090	.161	.206	.002
Prob-3							1.000	.309	.271	.142	.206	.213	.065
Prob-6								1.000	.359	.292	.193	.316	.160
Prob-8									1.000	.214	.189	.220	.064
Prob-9										1.000	.132	.321	.331
Prob-10											1.000	.255	.152
Prob-11												1.000	.265
Prob-12													1.000

Table 6.11

Showing Cluster Analysis by Correlation Coefficients listed in Order of Size o
Four ~~pyx~~ Psychological Tests and Nine identified Schemes of Thought Problems

Tasks (Problems)	Abb. for Tasks	0.000-0.049	0.050-0.099	0.100-0.149	0.150-0.199	0.200-0.249	0.250-0.299	0.300-* 0.349	0.350-* 0.399	0.400-0.449
PMT	(P)	-	-	12	8	9,10	-	2,11	A,6	N,1,3
NAT	(N)	-	-	12	2,3,10	V,1,8, 9	-	A	11	P,6
ANT	(A)	12	-	-	2	9	11,V, 1,3	10,N, 6,8	P	-
VNT	(V)	8	12	2,9,10 11	1	N,3,6	A	-	-	-
Prob-1	(1)	-	12	-	V,10	N,3,8, 9	A,2,11	-	6	P
Prob-2	(2)	12	9	V	8,N,A 6,10	11	1	P	-	3
Prob-3	(3)	-	12	9	N	V,1,10 11	A,8	6	-	P
Prob-6	(6)	-	-	-	2,10,12	V	9	11,A,3	8,P,11	N
Prob-8	(8)	V	12	-	P,2,10	N,1,9, 11	3	A	6	-
Prob-9	(9)	-	2	V,3,1	-	8,P,N, A,1	6	11,12	-	-
Prob-10	(10)	-	-	V,9	2,N,1, 6,8,12	P,3,11	-	A	-	-
Prob-11	(11)	-	-	V	-	2,3,8, 10	A,1,12	P,6,9	N	-
Prob-12	(12)	2	8,A,V 1,3	P,N	6,10	-	11	9	-	-

*Indicates columns of appreciably correlated set of problems which measure like aspec logical thoughts.

Current Factorial Structure of Adolescent Thought

Factors obtained in the current analysis cannot be directly compared with those others, obtained in previous researches, because of the various methods open, to obtain solutions of factoring correlation coefficients. Solutions to one factorial treatment with reference to another treatment has been described analogously with foreign money exchange systems (Holzinger, 1956), in which, one may get as solutions, money expressed in either (English) pounds, shillings and pence or in (American) dollars and cents.

However, there is a good deal of agreement about group factors which are being identified. A provisional list of them is of great research interest. Table 6.12 shows the current factorial structure list, related to the field of Adolescent Thought.

Table 6.12

Showing the Current Factorial Structure of Adolescent Thought

Factors	Psychological Interpretations	Author(s)	Year of investigation
First Factor	1) General Intellectual Factor	Abou Hatab	1964
		Beard	1957
		Delemos	1969
		Mac Arthur	1968
		Peel	1955
		Sandhu	1980
		Staver & Gabel	1979
		Tuddenham	1970
		Vernon	1971

	ii) Schematic Learning General	Bart	1971
		Renner & Lawson	1975
		Vaidya	1975
	iii) General Adjustment	Vaidya & Jain	1979 1982
	iv) Formal Operational Thought	Abramowitz	1975
	v) Exclusion of variables	Shayer	1978
	vi) Attainment Factor	Vaidya	1964
	vii) Algebraic Aptitude	Joshi	1970
	viii) Generalised Intellectual operations	*	1985
Second Factor	i) Piagetian Cognitive Development	Staver & Gabel	1979
	ii) Seeing the problem as a whole	Vaidya & Misra	1975
	iii) Academic Achievement Factor	Sandhu	1980
	iv) Adjustment	Vaidya	1975
	v) Practical Factor	Vaidya	1964
	vi) Symbolic Substitution	Joshi	1970
	vii) Grasping the Essence of the Problem	*	1985
	viii) Numerical Abilities	*	1985
Third Factor	i) Piagetian Logical Operations Test	Staver & Gabel	1979
	ii) Formulating Hypotheses	Vaidya & Misra	1975
	iii) Adjustment Factor	Sandhu	1980
	iv) Problem Orientation	Vaidya	1965
	v) Interest Factor	Vaidya	
	vi) Generalised Logical Thought	*	1985

Fourth Factor	i)	Interest in Generating difficult problems	Vaidya & Mishra	1975
	ii)	Behavioural factor	Sandhu	1980
	iii)	Sensing Problems	Vaidya	1975
	iv)	Tackling Algebraic Symbols	Vaidya	1975
	v)	Adjustment Factor	Vaidya	1964
	vi)	Insightful figural knowledge	*	1985
	vii)	Abstract Reasoning	*	1985
Fifth Factor	i)	Newness of the problem	Vaidya & Mishra	1975
	ii)	Emotional Factor	Sandhu	1980
	iii)	Problem Orientation	Vaidya	1975
	iv)	Symbolization	Vaidya	1975
	v)	Using common differences	*	1985
Sixth Factor	i)	Temperamental factor	Sandhu	1980
	ii)	Testing Hypotheses	Vaidya	1975
	iii)	Using Constant Difference	Vaidya & Manju Jain	1985
Seventh Factor	i)	Group Factor of Adolescent Thought I	Sandhu	1980
	ii)	Aspect Character	Vaidya	1975
Eighth Factor	i)	Social factor	Sandhu	1980
	ii)	Aspect Character	Vaidya	1975
	iii)	Exclusion of Variables	Vaidya	1975
	iv)	Verbal Reasoning	*	1985

Ninth Factor	i) Combinational grouping	Vaidya	1975
	ii) Seeing problem as a whole	Vaidya	1975
	iii) Grouping factor of Personality I	Sandhu	1980
	iv) Combinatorial Analysis	*	1985
	v) Probability & chance occurrence factor	*	1985
Tenth Factor	i) Intelligence	Vaidya	1975
	ii) Verbal Description procedures	Vaidya	1975
	iii) Abstract thinking factor	Sandhu	1980
	iv) Classification	*	1985
Eleventh Factor	i) Group Factor of Adolescent Thought II	Sandhu	1980
	ii) Conservation of volume	*	1985
Twelfth Factor	i) Stating & testing of hypotheses	Sandhu	1980
	ii) Stating Hypothesis	*	1985
Thirteenth Factor	i) Group Factor of Personality II	Sandhu	1980
Fourteenth Factor	i) Group Factor of Adolescent Thought III	Sandhu	1980

* Indicates factors obtained in the current study.

The above list of factors, reflecting structures of adolescent thought is, provisional and the factors, tentative, in the sense that they are pending much more exclusive research and verification.

CHAPTER VII

SUMMARY AND EDUCATIONAL IMPLICATIONS OF THE STUDY

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Introduction

Psychologists have provided us with a sequence of nodes, in individual's life span called infancy, childhood, adolescence, adulthood and old age which, Freud, Erikson and Piaget chose to describe in developmental stages. Freud (1900 and 1915) theorised and developed instinctual or drive stages of a person in a normal and pathological behaviour, in studies of psychoanalysis. Erikson (1950, 1959 and 1963) theorised and expanded the stage development, by focusing on the changing profile of an individual's Psychological conflicts. Piaget (1896-1980) formalised four major developmental stages covering the individual's life span period from birth till the age of 20 years. These are: (1) The stage of sensori-motor or practical intelligence, which constitutes, life span period, from birth till the age of 1/2 or 2 years; (2) The stage of pre-operational or pre-logical intelligence during which the child is subordinate to the adult, and

which constitutes, life span period from 2 to 7 years; (3) the stage of concrete intellectual operations, or middle childhood which marks, the beginning of logic, and of moral and social feelings of cooperation, and which constitutes, life span period, from 7 to 11 or 12 years; and (4) the stage of formal operations or of adolescence, of the formation of personality and of affective and intellectual entry into the society of adults, and which constitutes life span period from 12 to 16 or more years.

The Piagetian developmental stages have received worldwide acceptance and recognition, not only by scholars and researchers of Science Education and Social Sciences, but also by the larger community. Science Education singled out three concepts considered as Piaget' Chief contributions to Education. These are : (1) Piaget's concept of intelligence; (2) Piaget's concept of properties of or aspects of logical thought; and (3) Piaget's fourth developmental stage of pre-adolescent, as well as, adolescent period.

The current research project, in Science Education was designed to study aspects of Piagetian schemes of logical thought that certain groups of Ugandan adolescent pupils were capable or incapable of achieving and whether or not the pupils functioned at both, or one of the Piagetian levels, of concrete and formal operational stages. It employed four psychological tests and twelve schemes of thought problems. It studies the subjects' performance

scores on psychological tests and Piaget-type, schemes of thought problems. It also studied factorial structure of Schemes of thought problems; and proposed to identify, related educational implications. Its activities centered around the theme :

A STUDY OF SCHEMES OF LOGICAL THOUGHT AMONG CERTAIN GROUPS OF UGANDAN ADOLESCENT PUPILS WITH SPECIAL REFERENCE TO QUANTITATIVE KNOWLEDGE

Past Work

Piaget's work has had increasing influence on ontogenetic cognitive behaviour studies in: Science Education as well as, Social Science disciplines, both abroad and in India. Several research activities found the work an important means by which to understand child development and behaviour, for his education, welfare and care. Research in Science Education strongly endorsed the Piaget approach for..... developmental structures provide useful paradigm for development of researchable hypotheses.... and data, (Science Research Review Series, 1972). The following are a few of the research studies reviewed and having a bearing on the present study, starting with studies conducted abroad.

Inhelder and Piaget (1959) found that concrete operational subjects could describe results of their experiment, but failed to hold other factors constant;

and that formal operational thinkers did attempt to prove activities through control experiments. Lovell (1961) confirmed the Piagetian principles regarding capabilities of formal operational thinkers, and found out that, pupils of low academic ability failed to develop formal operations even pass their mid adolescence.

Jackson (1965) found out that about half of 15 year olds attained formal operational stage. Yadin (1966) found adolescent pupils of average intelligence, contrary to Piaget, showing concrete thinking behaviour; and that added age was, an important factor in the development of formal thought. Bart (1971) found that, in addition to the large general factors, formal thought did comprise verbal, as well as, non-verbal thought. Higgins-Trenk and Gaite (1971) found that, American adolescent pupils attained formal thought only, at the age of nineteen or so. Macke (1971) found out that all 15 year old adolescent pupils who, systematically approached the simple pendulum problem manifested formal operational thought. Dulit (1972) found out that, two-fifths of the gifted pupils (of 16-17 years) failed, to attain formal thought. Lengel and Buel (1972) found out that grades (7-12) showed gradual growth in logical operations of exclusion of variables. Lewis (1972) found out that formal operational thought, highly dependent on age rather than sex. Wells (1972) found out that when thinking was classified at : describer level; extended

describer level; explainer level; and using analogy and inference level, a wide spread of mean was noticed for both chronological and mental ages. Alasi (1973) found out that logical basis for conceptual thought disappeared when analysis of meanings varied on possibility and reflectivity. Wonsy (1974) found out that sub-urban cultural background promoted formal thinking. Bautista (1975) found no significant difference between concrete and formal operational pupils, who were tested on concrete thought problems only.

In India, Piaget-inspired studies have been vigorously pursued for well over one, or so, decades now. More Noticeable are the studies on adolescent thought conducted in Science Education, supervised by Professor N. Vaidya (whose monographs are published by the Extension Services Department of Regional College of Education, Ajmer). In it, Vaidya (1975) found mean scores on various schemes of adolescent thought increased with grade. Sandhu (1980) found significant correlations existed between intelligence and adolescent logical thought. Jain (1981) found problem solving ability differed significantly among pupils operating at three intellectual developmental levels. Padmini (1981) found majority of successful problem solvers were 14 year olds, and unsuccessful problem solvers, 10 year olds.

Tentative aspects of logical thought were shown in Vaidya & Padmini (1980) list of factorial structure of

adolescent thought, which included schemes of logical thought studied, by scholars and researchers based both abroad and in India. The findings with relevance to the present study include the following : (1) Generalised Intellectual Factors (Hatab, Beard, Peel, Vernon and Sandhu); (2) Exclusion of variables (Shayer, 1978); (3) Seeing the problem as a whole (Vaidya and Misra, 1975); (4) Formulating Hypotheses (Vaidya, 1975); (5) Using Constant Difference (Vaidya & Manju, 1984); (6) Combinatorial Grouping (Vaidya, 1975); (7) Symbolization (Vaidya, 1975); (8) Stating and Testing hypotheses (Sandhu, 1980).

Aims and Objectives of the Study

The following aims and objectives were proposed for study. They are : (1) To validate and extend the study of those basic concepts forming Piaget's conceptions of knowledge; (2) To study adolescent schemes of logical thought; (3) To investigate relationships of performance scores on four psychological tests and twelve schemes of thought problems, and study differences in the performance scores, sexwise, agewise, as well as, gradewise; (4) To study relationships in performance scores of Ugandan pupils with reference to parental occupations; (5) To investigate relationships between high and low total scores on twelve schemes of thought problems; (6) To investigate factorial structure of twelve schemes of thought problems administered to Ugandan pupils; (7) to point out the main educational

.cations arising from the study.

hoses of the Study

The following null hypotheses were proposed, and
d. They are :

There are no significant differences existing; agewise as well as gradewise in, Piagetian cognitive development, of Ugandan Pupils tested on : Raven's Progressive Matrices Test and Differential Aptitude Sub-test of Numerical Ability.

There are no significant differences existing; agewise, among performance scores of females and males of Ugandan pupils tested on : Raven's Progressive Matrices Test, and Differential Aptitude Sub-test of Numerical Ability.

There are no significant differences existing; agewise, among performance scores of Ugandan pupils studying in, three grade groups: Primary Seven (P7); Senior One (S1); and Senior Two (S2), tested on twelve schemes of thought problems.

There are no significant differences existing; gradewise, among performance scores of females and males of Ugandan pupils tested on, twelve schemes of thought problems.

There are no significant differences existing, among performance scores of, groups of Ugandan adolescents of 'peasant fathers, and housewife mothers', and 'Others', tested on, twelve schemes of thought problems.

(6) There are no significant differences existing between high and low performance scores of Ugandan pupils on, twelve schemes of thought problems.

(7) There does not exist any factorial structure of adolescent thought of twelve schemes of thought problems administered to Ugandan pupils.

The Subjects and Study Sample

A total of 616 Ugandan adolescent pupils studying in three grade groups (P7, S1, and S2), of 10 Ugandan Government schools were randomly selected as the study's entire pupil population. Of these, 263 were females and 353 were males. Gradewise, 212 pupils were studying in Primary Seven (P7), 192 pupils each were, studying in Senior One and Two (S1 and S2). The subjects belonged to three age groups (of : 13-14; 14-15; and 15-16 or more years), whereby, 312 were aged (from 13-14) years; 176 were aged (from 14-15) years; and 128 were aged (from 15-16 or more) years. By definition, they belonged to the fourth, Piagetian developmental stage of formal operations (of pre-adolescent and adolescent periods).

A sample of 270 pupils were randomly drawn from the 616 pupil population, using the principle of normality distribution of performance scores on, Differential Aptitude's Sub-test of Numerical Ability. Accordingly, a representative ~~and~~ study figure of 90 pupils, per each, of the three age groups were drawn up, of which, there were

equal agewise, and proportionate gradewise distributions of : 87 females and 183 males; 78 pupils (of Primary Seven); and 96 pupils each (of Senior One and Two).

Instruments of the Study

Out of several Piagetian problems assembled, modified and re-developed, twelve were, finally employed, as the instruments for studying schemes of logical thought. They are : (1) Water in Beakers Problem (for Scheme of Conservation of Volume); (2) Common Differences Problem (for Scheme of Using Common Differences); (3) Intersection Problem (for Scheme of Combinatorial Analysis); (4) Abstract Counting Problem (for Scheme of Observation, and Structuring in Coordinate and Perspective Systems); (5) Weight Comparison Problem (for Scheme of Seriation); (6) Two Front Division Problem (for Scheme of Classification); (7) Length of Shadow Problem (for Scheme of Proportionality); (8) Flow of Liquid Problem (for Scheme of Stating Hypotheses); (9) Jokers Cards Problem (for Scheme of Chance Occurences and Probability); (10) Nine Dots Problem (for Scheme of Insightful, and Figural Knowledge; (11) Think Things Out Problem (for Scheme of Grasping Essence of Problem); (12) Balance and Step-by-step Measurement Problem (for Scheme of Generalised Logical Thought).

Their Kuder Richardson Reliability Coefficients (r_{11}); Point Biserial Item Validity Index (r_{pbi}); and

Difficulty Index or Facility Value (F.V.) calculated, for the sample (N = 270) were the following :

Problem 1 : (r_{ii} = .77; r_{pbi} = .73; F.V.=.58)
Problem 2 : (r_{ii} = .69; r_{pbi} = .85; F.V.=.82)
Problem 3 : (r_{ii} = .82; r_{pbi} = .87; F.V.=.83)
Problem 4 : (r_{ii} = .32; r_{pbi} = .16; F.V.=.58)
Problem 5 : (r_{ii} = .38; r_{pbi} = .74; F.V.=.61)
Problem 6 : (r_{ii} = .73; r_{pbi} = .41; F.V.=.46)
Problem 7 : (r_{ii} = .53; r_{pbi} = .70; F.V.=.35)
Problem 8 : (r_{ii} = .57; r_{pbi} = .57; F.V.=.53)
Problem 9 : (r_{ii} = .81; r_{pbi} = .31; F.V.=.70)
Problem 10: (r_{ii} = .75; r_{pbi} = .27; F.V.=.81)
Problem 11: (r_{ii} = .65; r_{pbi} = .93; F.V.=.43)
Problem 12: (r_{ii} = .80; r_{pbi} = .36; F.V.=.47)

Problems 4, 5 and 7 were eliminated at the Factorial Structure Analysis Stage.

Four Psychological Tests were also employed in the study. They are :

1. Raven's Progressive Matrices Test;
2. Numerical Ability Test;
3. Abstract Reasoning Test; and
4. Verbal Reasoning Test.

Raven's Progressive Matrices Test was used to ensemble evidence of subjects' general intellectual ability measured in terms of performance scores. The other three :

Differential Aptitude Sub-tests were administered, with the aims of predicting the subjects' future abilities in such schemes as of Numerical Ability, Abstract Reasoning and Verbal Reasoning.

The Main Findings of the Study

Subsidiary findings of the study being numerous, the main findings indicated that :

1. Mean scores of four psychological tests were better performed by higher grades of the subjects;

2. Female mean scores on, Raven's Progressive Matrices, and Differential Aptitude Sub-tests of Abstract, and Verbal Reasoning decreased, with increased age, unlike male mean scores which flunctuated;

3. Younger subjects (of 13-14 years), as well as, children of teachers, doctors, managers, bankers, accountants, and other professions showed, better performance scores on tests of Raven's Progressive Matrices, and Differential Aptitude Sub-tests of Abstract, and Verbal Reasoning;

4. Mean scores on Numerical Ability Test were better performed by males; increased generally with age and grade; decreased with increases in female age; and were shown topping in favour of children of peasants and house-wife mothers;

5. Better mean scores, on problems of schemes of thought were shown, in favour of males, as well as,

subjects of Older age (of 15-16 or more years);

6. All mean scores on schemes of thought problems increased, with grade;

7. Majority of female mean scores on twelve schemes of thought problems fluctuated in between, and a cross groups of age, as well as, grade, unlike male mean scores which generally increased with age, as well as, grade;

8. Children of peasants and housewives showed more higher mean scores on schemes of thought problems compared to the frequency of higher scores of the children of "Others";

9. Children of the group of teachers, doctors, managers, and other professionals performed better on such schemes as : Conservation; Seriation; and Classification; while children of peasants and housewives performed better on such schemes as : Using Common Differences; Combinatorial Analysis; Stating hypotheses; Probability; Insightful and Figural Knowledge; and Grasping Essence of Problem; Mean scores on schemes of Proportionality and Generalised Logical thought were shown evenly performed by the two groups;

10. Tests for Piagetian Cognitive Development Stage showed significant differences, existing between groups of Ugandan pupils' gradewise. No significant, agewise differences were found existing between females and males.

11. No significant differences existed agewise between Ugandan pupils studying in Primary Seven (P7), Senior One (S1) and Senior Two (S2).

12. No significant differences were found existing between Ugandan pupils of high and low total scores of twelve schemes of thought problems;

13. Three Hypothetical Common Factors were found possessing, more than unity, of estimated eigen values. They accounted for 49.5 percent of the total variance of the variables subjected to factorial analysis. Cattell's Scree Test too established the existance of the same number of common factors, for the sub study;

14. Interpretation of identified factors (of $\pm$ .300 magnitude) revealed Nine Significant Schemes of Thought, which constituted the enlisted factorial structure of the studied schemes of logical thought. They are, namely : Generalised Logical thought; Grasping Essence of Problems; Stating Hypotheses; Insightful and Figural Knowledge; Using Common Differences; Combinatorial Analysis; Probabilistic Reasoning; Classification; and Conservation of Volume.

Educational Implications of the Study

The general principle of Piagetian schemes of thought focuses on, the role of mental representation in which, a given period of behavioural development is explained,

in the context of mental activities exhibited. Piaget (1971 & 1975) has exemplified this, when differentiating between figurative and operative aspects of thought, in which figurative aspects of thought comprise mental signifiers, such as images, symbols and words, that, stand for particular stimuli representing the covert speech, and other mediating responses hypothesized by S-R mediation theorists. The operative aspects of thought comprise mental schemes which, in the case of an infant (of under 2 years) show organised mental activities, analogous to overt sensory-motor schemes; but in the child (of 2 to 7; 7 to 12; and 12 to 16 or more years) describe, conceptual activities of the child, manipulating the contents of his thought. Unlike schemes, schemata are the components of figurative aspects of thought, and the schemes, the components of operative aspects.

Four psychological tests, and twelve schemes of thought problems studied, revealed the characteristic mental activities which confirmed some of the Piagetian presuppositions regarding children's abilities, stages of informal experiences, and the types of experiences the children are capable of. It was found that the children could apply formal logic to abstract, and conceptualise solutions to problems and tests, in terms of possibilities. They deduced solutions logically from initial terms of the problems. They conceptualised solutions to the problems in terms of all possible relations. The implications of these presaged the following understanding on Science Education of adolescents:

That -

1. Younger subjects (of 13-14 years' age) showed striking intellectual abilities, and better performance scores on tasks involving pictorial, spatial, as well as, linguistic manipulations, and expressions, thus indicating a basis on which planning for such youngsters' subject courses in which plenty of exercises, such as of figures, that rely upon working with symbols, objects, etc., are included;

2. Female subjects' performance scores decreased with increased years, of age on, tasks of intelligence, and numerical abilities; suggesting thus, a caution, and careful consideration, to be given when planning their instructional courses, which are to match with levels of their abilities identified, as well as, with their appropriate age ranges;

3. The increasing trend of performance scores, with grades, on Numerical Ability, and Verbal Reasoning Tests; suggests the necessity of organizing, and emphasizing grade-based language, and mathematical education programmes in which, the frequency of subjects taught should increase with grade;

4. Younger subjects' top performance scores shown, on such schemes of thought as : Using Common Differences; Observation and Structuring; Classification; Probability; and Grasping the Essence of the Problem, have confirmed, the kinds of informal experiences and logic-based operational

schemes of thought, which the subjects were found capable of. The implications of these suggest ideas to formulate for the cohorts broad-based general educational programme, which are developmentally planned;

5. The various aspects of logical abilities identified with reference to sex, age, grade, and socio-cultural backgrounds of the subjects call for the adaptation of new, and preferably open systems of educational programmes; and techniques of measurement and evaluation focused on scientific, and psychometrical, orientations.

Suggestions for Future Research

The main findings of the study have raised serious issues for future researches. Key among them are :

1. A model scheme of adolescent thought, within the context of Piagetian concepts of knowledge.
2. Certain characteristic responses of Younger Age Subjects (of 13-14 years) performance scores on Raven's Progressive Matrices Test.
3. Effects and influences, of specific schemes of logical thought on Science Education Programmes for adolescents.

Accordingly the following themes have been suggested for future research. They are :

1. A study to determine the quality of Science Education that influences most, pupil performances, on certain aspects of schemes of logical thought;

2. Analysis of adolescents operations involved, in arithmetic calculations, using conventional, and unconventional symbols.

3. Philosophical study of implications of Piaget's formal operational stage, for priorities in the teaching and learning of mathematics.

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APPENDICES

APPENDIX A*

Twelve Schemes of Thought Problems

REGIONAL COLLEGE OF EDUCATION

AJMER INDIA

SCHEMES OF
"A STUDY OF LOGICAL THOUGHT AMONG CERTAIN GROUPS OF ADOLESCENT UGANDAN PUPILS WITH SPECIAL REFERENCE TO QUANTITATIVE KNOWLEDGE"

Particulars of the Pupils

1. Name (s) ______________________________
2. Sex (Male/Female) ______________________________
3. Date of birth and Age (to date) ______________________________
4. School (Name / Address) ______________________________
   ____
   ____
5. Class/Grade (with section or stream) ______________________________
6. Nationality ______________________________
7. Father's occupation ______________________________
8. Mother's occupation ______________________________
9. Date (to-day) ______________________________

*Tables 6.8 and 6.9 show Factor-Analytic Description of the Twelve Schemes of Thought Problems

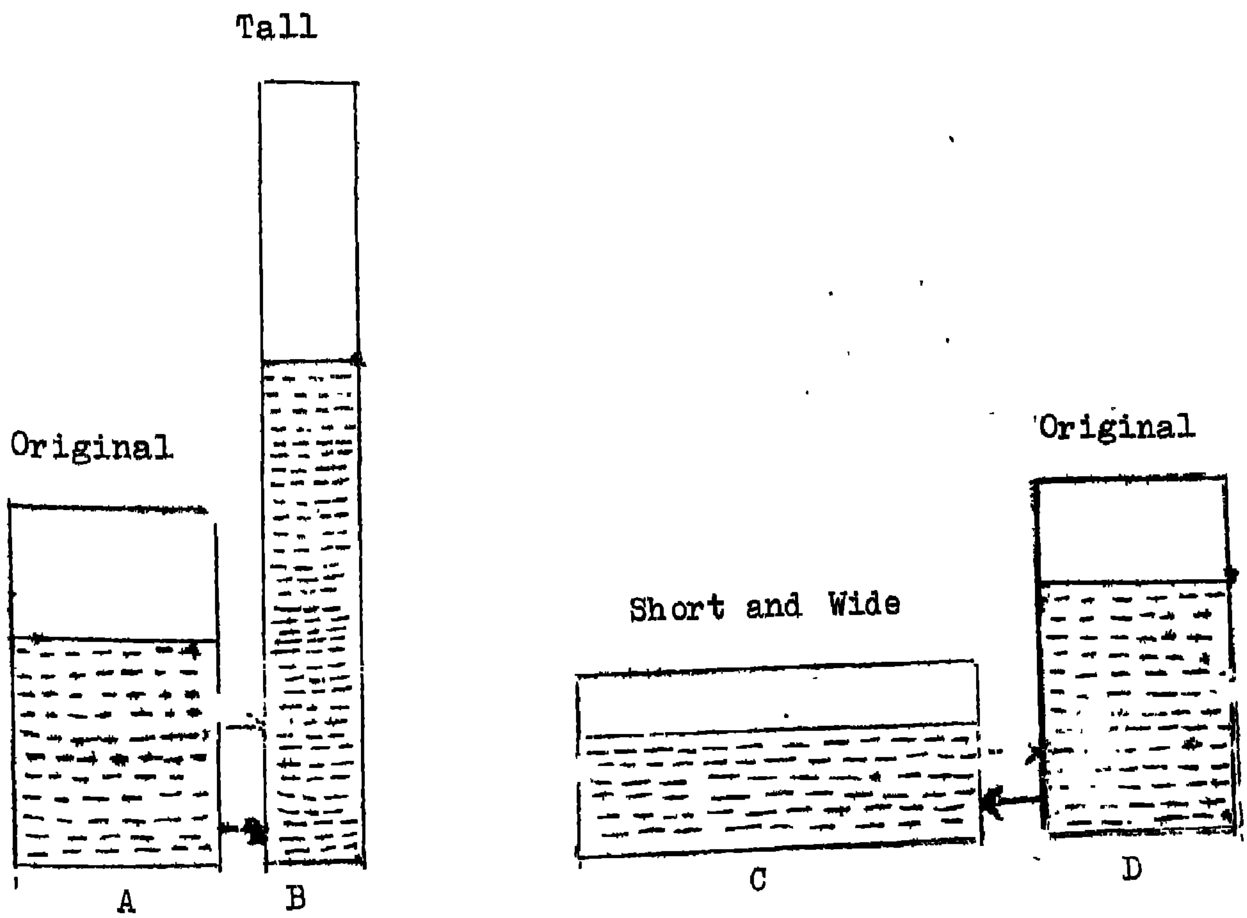
PROBLEM No.1

WATER IN BEAKERS PROBLEM

Instructions

Study carefully the photographs arranged below. Four beakers : A, B, C and D are seen. Beakers A and D are known to be original and having equal size and capacity of say 200 cc. Beaker B is tall but narrow, while beaker C is short but wide. Equal amounts of water of 50 cc are poured, first from beaker A into B and then from beaker D into C. You are required to give only one answer out of the two choices : Yes or No? at the end of the questions.

The Photographs



The questions :

1. (a) The level of water in beaker B is higher than the level in beaker C. Yes or No?

   (b) The level of water in beaker C is the one higher. Yes or No?

   (c) The levels of water are equal in both beakers. Yes or No?

2. (a) The amount of water in beaker B is more than the amount in beaker C. Yes or No?

   (b) The amount of water in beaker C is the one more. Yes or No?

   (c) The amount of water in both beakers is the same. Yes or No?

3. (a) The volume of water in beaker B is more than the volume of water in beaker C. Yes or No?

   (b) The volume of water in beaker C is the one more. Yes or No?

   (c) The volume of water is the same in both beakers (B and C). Yes or No?

PROBLEM NO. 2

COMMON DIFFERENCES PROBLEM

Instructions

Study carefully the system below of paired numbers. Two unequal, common differences (d_1 and d_2) exist, between the set of pairs. d_1 represents the common difference calculated latitudinally (i.e. horizontally) while d_2 represents the common difference calculated longitudinally (i.e. vertically).

The horizontal calculations involve the paired numbers: 5 & 2; 9 & 6; 13 & 10 etc., while the vertical calculations involve the paired numbers : 6 & 2; 9 & 5; 10 & 6; 13 & 9; etc.

The pattern of the system

```
2-----5
|     |
6-----9
|     |
10-----13
|      |
14-----A
|      |
B------C
```

Question 1 (a) : The value of d_1 is ______.

1 (b) : The value of d_2 is ______.

Question 2 (a) : The number A stands for______.

2 (b) : The number B stands for______.

2 (c) : The number C stands for______.

PROBLEM No.3

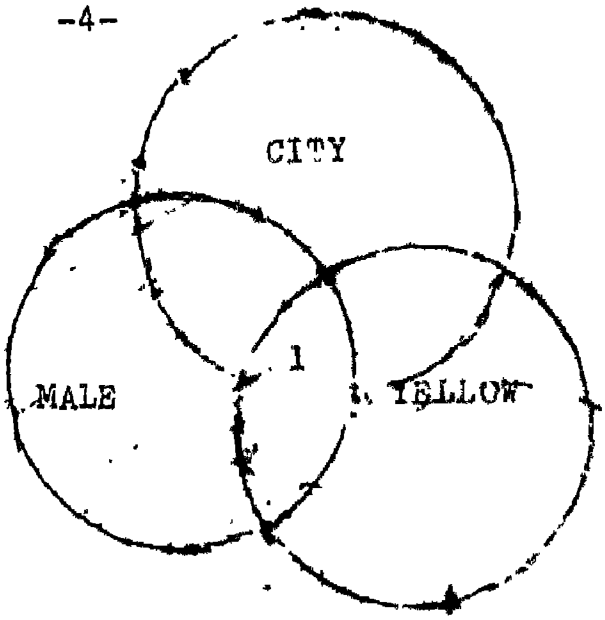
INTERSECTION PROBLEM

Instructions

Carefully read and understand the following information about an intersection of three groupings of people. One group is made up of the people who live in the city (C); a second group is made up according to the people's colour of skin, say yellow (Y); and the third group is made up according to the people's sex, say Male (M) people.

The photography below shows the intersection. It is shaded and marked I. The members of the intersection therefore include: the city people (C) ; the yellow people (Y); and the male people (M).

Contd.



The Questions :

1. The intersection is made up of the male people with the city people, i.e. MnC = I. Yes or No?

2. The intersection is made up of the yellow people with the city people, i.e. YnC = I. Yes or No?

3. The intersection is made up of the Male people with Yellow people, i.e. YnM = I. Yes or No?

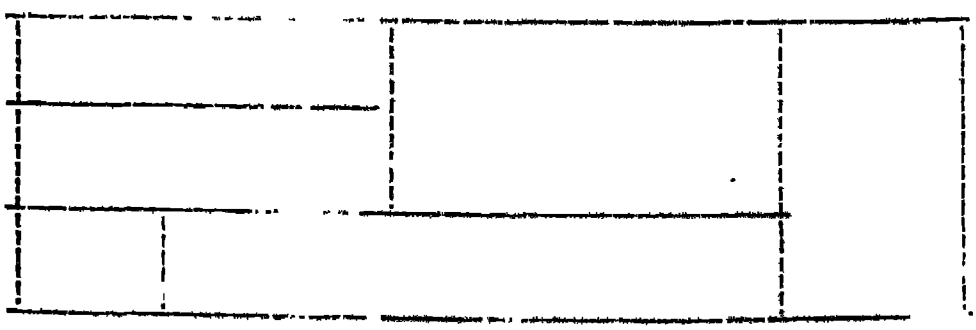
4. The intersection is made up of the city people, the yellow people and the male people, i.e. CnYnM = I Yes or No?

PROBLEM No.4

ABSTRACT COUNTING PROBLEM

Instructions

Study and understand the figure below and the questions that follow :



Questions :

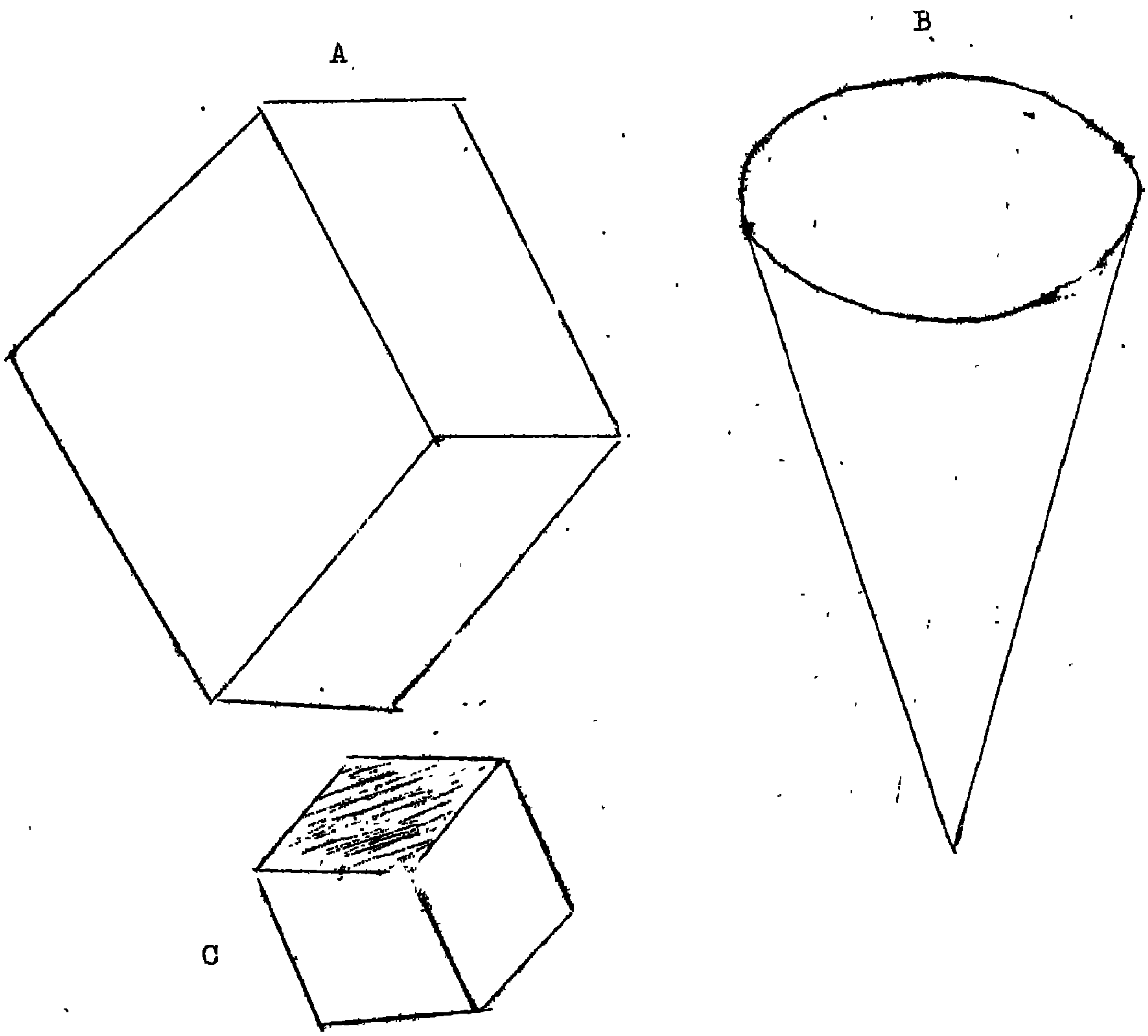
1. How many lines has the figure?
2. What is the maximum number of the rectangles seen in the figure?
3. If the figure is a foundation stone laid, of a building, how many rooms has the foundation?

PROBLEM No. 5

WEIGHT COMPARISON PROBLEM

Instructions

Study carefully the three blocks, A, B and C arranged as shown in the photograph below and then answer the question that follow. It is known that block C is heavy block B is heavier while block A is the heaviest.



The questions :

1. Block C is lighter than block B? Yes or No?
2. Block C is lighter than block A? Yes or No?
3. Block A is heavier than blocks B and C put together Yes or No or Depends?
4. The blocks can be arranged according to their weights, starting from light, then lighter and finally the lightest. Yes or No?
5. Using the letters: A, B and C, which, respectively, represents the blocks, arrange an order say of heaviest to heavy or lithtest to light.

PROBLEM No.6

TWO FRONT DIVISION PROBLEM

Instructions

Study carefully, the step by step breaking-down of a classification of certain groups of human beings shown below. The name of class represented with (?), is asked in question No.3.

- ?
  - Students in the school
    - Senior one students
      - Senior one Boys
        - Senior one boys who play football
        - Senior one boys who do not play football
      - Senior one Girls
    - The rest of other students of the school
  - Outsiders (i.e.outside people)

The questions :

What is the class made up of :

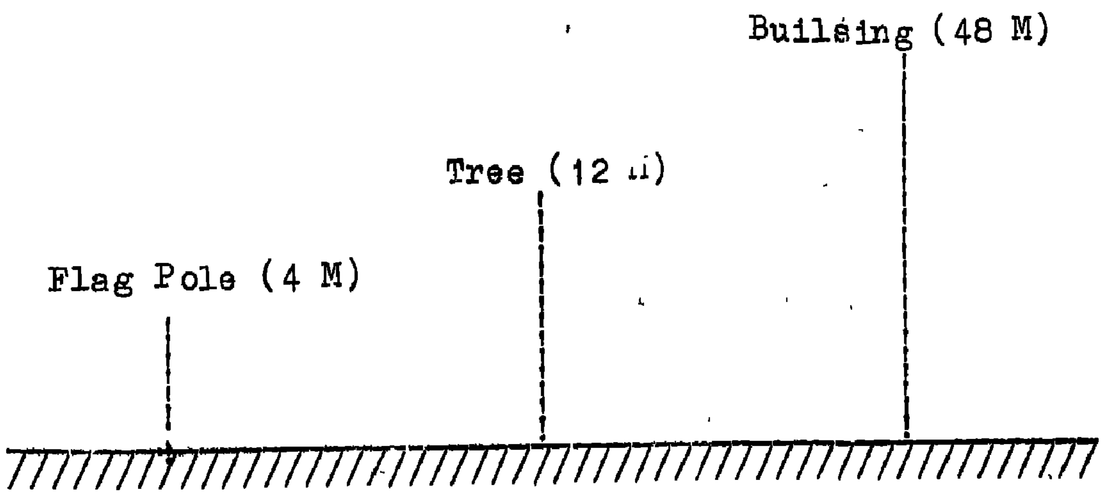
1. Senior one boys and senior one girls called?
2. Senior one students and the rest of the students in the school, called?
3. Students in the school and the outsiders, called?
4. Senior one students and senior one girls, called?
5. Senior one boys who are football players and senior one boys who are not football players, called?

PROBLEM No.7

LENGTH OF SHADOW PROBLEM

Instructions

Imagine, you are looking at three objects, namely a building (which is 48 M) high, a tree (which is 12 M high) and a flag pole (which is 4 M high). The following (not drawn to scale) shows their representations.



If it is known that the length of the shadow (which the tree casts) is, 18 M, and judging from the length of shadows you may calculate (or otherwise), estimate the time or the moment when, the shadows were cast.

Questions :

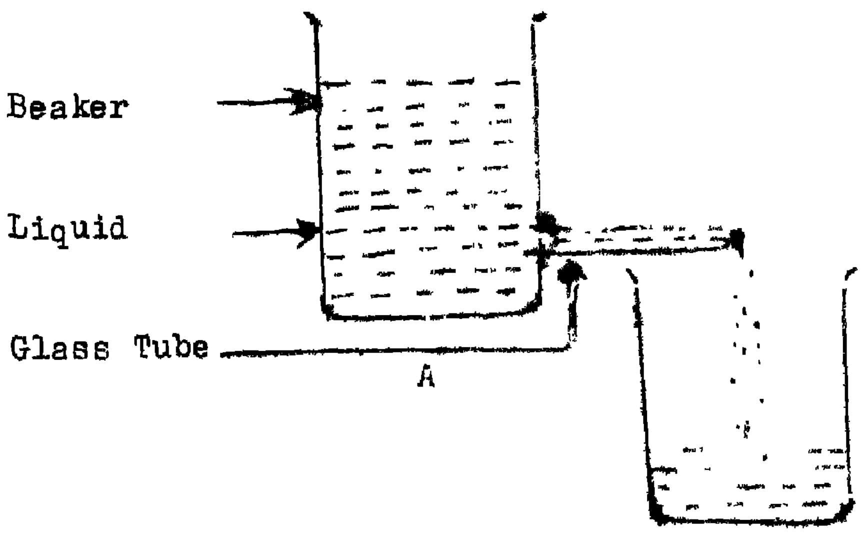
1.	Was it in the evening?	Yes or No?
2.	Was it in the morning?	Yes or No?
3.	Was it at noon?	Yes or No?

PROBLEM No.8

FLOW OF LIQUID PROBLEM

Instructions

Study carefully the flow of liquid from a beaker A into another beaker B. The photograph below shows the flow.



Questions :

1. The amount of liquid collected in beaker B will be more or less if :

   (a) The size of the hole in the glass tube is large or small. Yes or No?

   (b) The amount of liquid in beaker A remains high or low. Yes or No?

   (c) The size of the glass tube, through which the liquid flows is altered. Yes or No?

   (d) The length of glass tube through which the liquid flows is long or short. Yes or No?

   (e) Beaker A is placed (at all times) higher than beaker B. Yes or No?

2. Write, giving reasons why more liquid will be collected if beaker A remains filled, at all times.

PROBLEM No. 9

JOKER'S CARDS PROBLEM

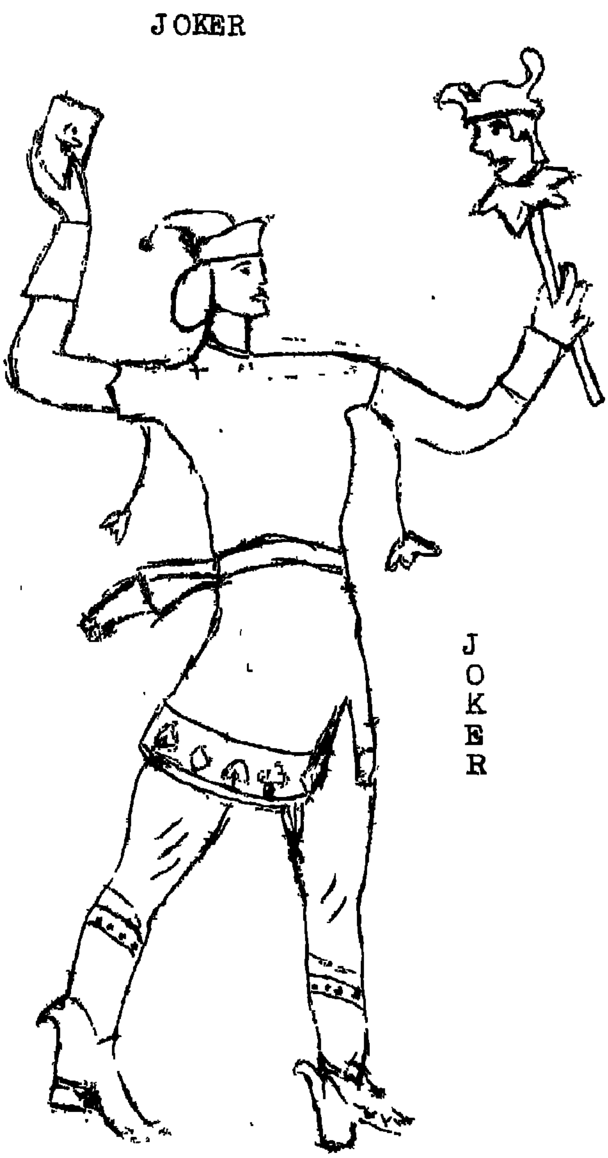
Instructions

The photograph below illustrates cases when certain sets of cards are picked and then shown. Four of such shows are recorded in a table, arranged at the side of the photograph. The chances in each show, for picking cards marked with jokers in both right hand and left hand sets are found, by adding the numbers of those cards marked with jokers in the right, and left hands; and the sum, divided by total number of cards shown. You are to write the answer or say the quotient in the blank spaces provided in the table.

Table

Showing details of the sets of cards shown in a game of Joker's cards

S. No.	The show	Position of the sets	No. of cards marked with Joker's	No. of cards un-marked	Total No. of cards shown	Chances of picking cards marked with jokers
(a)	First show	Right hand	4	1	11	
		Left hand	4	2		
(b)	Second show	Right hand	4	1	9	
		Left hand	3	1		
(c)	Third show	Right hand	2	1	9	
		Left hand	4	2		
(d)	Forth show	Right hand	2	1	10	
		Left hand	5	2		



The questions :

1. Arising from the calculations in the table, the chances of picking cards with jokers in :
   - (a) The first show is ______
   - (b) The second show is______
   - (c) The third show is______
   - (d) The fourth show is______
2. Is it in (a) or (b) or (c) or (d) that the chance is the greatest?
3. What is the numerical value of this greatest chance found, in Q.No.2?
4. Arrange the chances of picking cards marked with jokers (obtained in Q.No.1) in increasing or decreasing order.
5. State a rule by which you can tell where chances of picking cards marked with jokers, lie.

PROBLEM No. 10

NINE DOTS PROBLEM

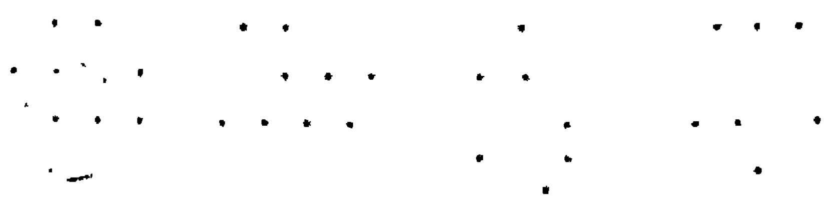
Instructions (As per questions)

Question 1 : Four sets of "nine dots are marked as shown below. Draw only four straight lines in order to cover the dots in each case

(a) (b) (c) (d)

Question 2 : Arrange two more sets of the "nine dots" and join them in each case with only four straight lines, whose pattern should appear different from those of Q.1.

Question 3 : Try drawing a number of straight lines to pass through a different arrangement of four sets of "nine dots" shown below :



(a) (b) (c) (d)

What is the minimum number of straight lines obtained in such cases?

PROBLEM No. 11

THINK THINGS OUT PROBLEM

Instructions (As per questions)

1. How many drops do you get when you add a drop to another drop?
2. How many corners are left when one of the corners of a handkerchief is torn off?
3. There are eighty birds sitting on a tree. A hunter shoots dead two of them. How many birds are now left sitted on the tree?
4. Some ducks are seen swimming under a bridge. Infront there are two and behind there are also two ducks seen. If two more are again seen swimming in the middle, how many ducks are there in all?
5. Supposing that you are now 16 years old. Four years ago, your father's age was 3 times your age.
   How old is your father now? Can I say that he is now :

   (a) 36 - 4 years old   Yes or No?
   (b) 36 + 4 years old   Yes or No?
   (c) 3 x 12 years old   Yes or No?
   (d) In none of the above   Yes or No?
6. Spot out the dissimilar or the stranger in the following two sets of arrangements :

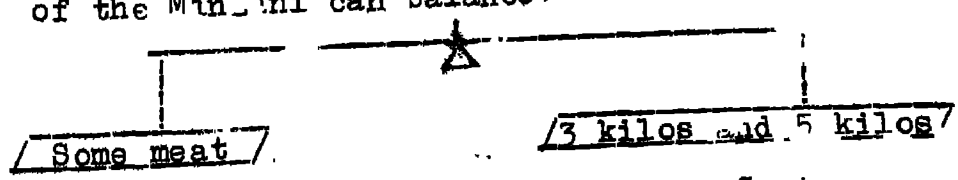
   (i) 15 26 9 71 84 90
   (ii) A L Y K B M

PROBLEM No.12

BALANCE AND STEP BY STEP MEASUREMENT PROBLEM

Instructions (As per questions)

Question 1 : The diagram below shows two weighing stones being placed on one side of the weighing machine (minzani), and some unknown weight of meat is placed on the other side. If the weights of the stones are 3 kilos and 5 kilos respectively, how many kilos, should the meat be, so that the two sides of the Minzani can balance?



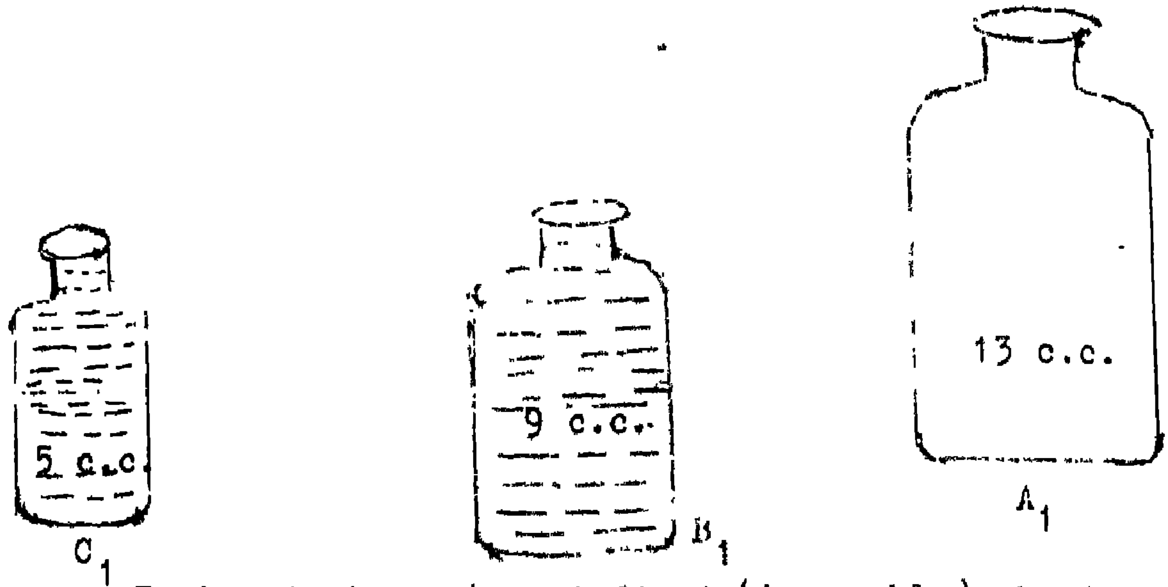
Cont...

Is it (a) 3×5? Yes or No?

(b) $3 + 5$? Yes or No?

(c) None of the above Yes or No?

Question 2 : Three beakers : A_1, B_1 and C_1 are placed on a table as show below.



Beaker A_1 is empty and fixed (immovable), having a capacity of 13 cc, while beakers B_1 and C_1 are movable so that they are filled or emptied as and when the need arises. Beaker B_1 has a capacity of 9 cc and beaker C_1 has 5 cc. In order to fill beaker A_1 completely using beakers B_1 and C_1 only a number of steps need to be taken. Three steps are given below as an example. You are required, to write at least six of such type of step by step approaches to fill in the empty beaker A_1.

Step I : Pour away the water in Beaker C_1

Step II : Fill beaker C_1 with more water from beaker B_1 leaving in beaker B_1 only 4 cc of water

Step III : Pour away, once more, the water in beaker C_1 so that the remaining 4 cc of water from beaker B_1 is poured into the emptied beaker C_1

The photographs show, the positions and assumed sizes of the three beakers. And you can incorporate the above three given examples into your final answers (if you see them fitting).

APPENDIX B*

Original Scores of Twelve Schemes of Thought Problems and Four Psychological Tests

0011111221412130904835414522440233936001

0021111132611251508080213213560243734002

0032111213412241608633413014220453027003

0041111213015241808744124110470223238004

0051111113312241708645432012470433935005

0061111223414191207973104302360243532006

0071111215213311611272413013360523734007

0081111225014371511695435425661096865008

0091111113314311209065423113460234037009

0102122111717392012575433214430434340010

0112122113920241810165423213440534239011

0122122113024181208453112002460343128012

0132122344422271911265423213440534239013

0141122414514271710075423213460454643014

0151122213214181808263112112340142926015

0161111114413231409454213003440633532016

0171111110818110704055424503460454744017

0182111114512191108575424424640545148018

0191111112815241508253413214450564340019

0201111113515281409294414024560434744020

0212111113612230807991202203660454037021

0222111113514211408453404103460243633022

0231111113214242009062423213340243633023

0241111112813081406374212003420243128024

0252111112514071906563212101610683734025

*Table 4.1 shows Instructions on Reading Appendix B

026[illegible]11[illegible]1309275423114460434441026

0272[illegible]301[illegible]111542511344053423 9027

02821[illegible]11[illegible]2817111542320346074464 3028

029[illegible]1222151[illegible]020231145421435660755148029

0302122[illegible]192130221229424413460544946030

03121[illegible]2115[illegible]3028151269424435750846056031

0322122111[illegible]1520180993422213460434340032

033213211[illegible]72122214104542221346054434 0033

03411222136151316080541131124410233734034

0351122213718182[illegible]9364131124306337340 35

036121111121217090505112103460143239036

0371211111713200305834231035403337 34037

03821111143152718103542311316023373 4038

039211122321218160788412303560434037039

0401211225112301310684123034604640 37040

0411211111361207170725841200446075373 4041

0421211213715221508954423224450464542042

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0451211314212291810175423211460434739045

0462111111712201106052112103440463330046

0471211112211221006565123103460233633047

0481211212213240606555423213450344441048

0491211111313190505465122113460333734049

0501211111416201106175122113460333835050

0511211113914211108375432114440334138051

0521211113817201708765422113460344138052

053211121321319160997542233420333936053

0542111313114281108464423314450464643054

0552122113917311810563122112440343229055

0562122114824292112275423213460234739056

0572122113820291710465422214460784643057

0582122111313151005153123113440433431058

0592122115221341812595425524460845855059

00602122313815231409055413203440523936060

0612122113517121307763113113440333532061

0622122213619291710165123221340333532062

0632132234729172111295413531660665552063

0642122125017252011295434535660886663064

0652122114919171409960403111450333128065

0662122114020301710254423523450434441066

0672132233921281109973424503750765349067

0682122224512210908795123324460544845068

0692122113820191309065412203460374340069

0702122114113210808375423214440334239070

0712122313016201509165423204440344138071

0721132215018331811975432213450534441072

0731132114818311711465423203430033532073

0742132114977332113065423313440344138074

0752132114027171109553433314460334739075

07611222112617131106753113102230232623076

0771122221519161506653112002460142926077

07811221132171213071631131134130253330078

0791122331616086404952123112440633431079

0801142213715241809463412213460333835080

0811132211020191008965423203440454239081

0821132223515241108663412213460333835082

083113211112116110891542321344054441083

0841132114117111208185435313460735749084

0851132224327282111963413212140574239085

0862132114129321111675423312460572946086

0872132114029281911685423013460554643087

0882211211812261407053113202460633633088

0892211112816160706751224202340233027089

0901311213110221207894114024460221239090

0911311221113251109333111024560233431091

0921311234318261740405413332140845047092

0932211113713191708653213013460764441093

09422111113813221608993121213450634340094

09522112137122216087954125524560586057095

0962211213713152008565423213440354239096

0972211314612302211085423212460534542097

0981311112915031306035423102420583936098

0991311111716111706154101013440553330099

1002211113415171808463212102420253027100

1012211112815121106663112112440333128101

1021311112714181007965422313430243936102

1031311111315380807975423214460755049103

1041311111714230906375422113450233936104

105221111331632120939541102133405341037105

10622111131152711084554222144130233734106

1072211111712241506853423212420233330107

1082211112213131005853422114440233532108

1092222214209201808995425314460755754109

1102222113927321511353413213430643936110

1112222111014111708265423203430333835111

1122222113426261009653123203550343633112

1132222213214111307053412214330233330113

1142222211224200806453112103330533027114

115222221502134191247542321244 434138115

1162222210914331607253112113440343229116

1172132214621251511083114515050364613117

11821321114426371211494323114760634945118

11921321144293417124554114125470495147119

1202132114324201310065412404850295045120

1212132114831321612795424525660335451121

1222132115327172211995411402460685350122

1232132113518291509795421313720634945123

1242132413825261710175311204460774744124

1252222215028382013695434434560735754125

151123221 1021302011153423213460573532151
152123221 1720211600475432203140534239152
1532132113727151008963133223460734340153
1542132114621211911055433213430634239154
155213211 122231309955133313460674744155
156213221 1431181 110765423214350734037156
1571222213516101807953123102430232926157
1581222313917151008175422203460244138158
1591222213118210808165403103460533936159
1601222111615140905453212102310142825160
161122213171 1140708295425113430544643161
1621222113817181108472123212330543532162
16312321130152310098531221134604133532163
1641232113515191208163423213460334037164
1651232115015191308795423223540745047165
1661232223812101207765425313340534441166
16712322141118122709885425323460575451167
1681232114621301811553423213460544239168
1691311112913151407155410112440373239169
1701311111016110804553221113530553835170
1712311114521341611754124333760295248171
1722311113021081707663121103420343027172
1732311213920361101695423213460344643173
1742311113915351110075423203460344340174
1752322114129301611665425514450334744175

1762322114332321812573425516640635249176
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1812232114631331412495434423860896561181
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1832232234324331111495414205470375147183
1842232214730171310792424512460575148184
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1862322115033321813355424525660745552186
1872322214431311512193413213450534340187
1882322114932341312835414423430534138188
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1912322215025382113475424314440531643191
1922232514428300911153424130760895248192
1932232113931271811533424525760455046193
1942232114630270911293135534030534441194
1952232214327321011273214533700424137195
1962232214217312011075425705560755350196
1972232114732282012795424432760855955197
1982232113831311211295433134720655248198
1992232113518321109674413415660975754199
2002232114114271910193424525760696258200

2012232113925321711395423525660435451201

2022232214326180809593113112470594617202

2032232221502730181259542452475047585 4203

2042322211452024121017542321346053454 2204

2052322114318261208975422213460544547205

2062322114008171207775412213460544441206

2072322114915261310375423214460544744207

2082322112813160706473112213440333229208

2092322114431241811765423213460544542209

2102322114317201408975423213440334138210

2111322213306191106953112112430202522011

2121322114825191510775423223460344542212

2131322511912121305653111103420442926213

2142232513925131008785411213430634037214

2152232312020181608453123211440333532215

2162232114826201811265433323430734643216

2171322214410161108175425213530274643217

2182322214214251609795423112460344441218

2191322213517142008665425212430454340219

2201322213715191508665413212430133532220

2211332314217251009475423213440544441221

2221332214719301811495425424660835855222

2231332513720231909955425213440143633223

2241332214218212311465415202460334138224

2251332113817201509055425313460244441225

22613322139181617090634232134402337342 26

2272311113217271709394324423460234643227

2282311113908121507455423213460734037228

2292311114315271710253432412460233936229

2302311114609201709285423213460454744230

2312311114020251510083414303460434340231

2322332114329141410075423414660675552232

2332322114326271710895423525660545653233

2342332115334312013885423334750755652234

2352332112717291208553423014460794845235

2362332114021280008995424415560755754236

2372332113719311209955412315460654744237

2382332214632302213075424435460234946238

2392332114529281311574425334760696056239

2402332114431292012483424334770325045240

2412332112123271508963432505160634441241

2422332113128271810473424436460333936242

2432322113421191108565423213460574845243

2442322113408170806753413213440333633244

2452322114014231208975425214460544946245

2462322115325301612495433214460735148246

2472322214318211408675422213440344138247

2482332114429242211983323213520734239248

2492332231423018070976541320345034403 7249

2502332114826201811255423212460734340250

2512332111521211006753432214460734441251
2522332113620221209065433203460534441252
2531322114220151208975425213330144037253
2541332214217201609563123113440233330254
2551332223018211608555423213460544441255
2562311113012211207563423212430243633256
2572311211314100804554201203400453027057
2582311212011061105151112112440263027258
25923222111819281017553423314460734542259
2602332114730271211275414413360935047260
2612332114015201308854323114460774744261
2622332214026231510495414214450544845262
2632332114130221911265223213460634340263
2642332114423281711275423214460344542264
2652332114829281912475423213460574946265
2662311111417171005842101102430232320266
26723222114326202010065422213460434239267
2682332113629281110465422314410334138268
2692332111415170905553413314460233936269
2702332113328191209275413102560934643270

APPENDIX C*

Comparative Sex & Grade Norms** of DAT Sub-tests of Numerical Ability Abstract Reasoning & Verbal Reasoning

FORM **A** GRADE **8**

N =3400 ±

Raw Scores								
Num. Abil.	Abs. Reas.	Space Relo.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR+NA	Percentile
31+	43+	83+	59+	71+	83+	54+	61	99
29-30	40-42	76-82	53-58	63-70	73-82	45-53	56-60	97
26-28	38-39	70-75	50-52	59-62	62-72	40-44	51-55	95
24-25	35-37	64-69	46-49	55-58	54-61	35-39	46-50	90
22-23	33-34	59-63	44-45	53-54	46-53	32-34	42-45	85
20-21	32	54-58	42-43	51-52	40-45	29-31	40-41	80
19	30-31	51-53	40-41	50	35-39	27-28	38-39	75
18	29	47-50	38-39	48-49	31-34	25-26	36-37	70
16-17	28	42-46	36-37	47	26-30	23-24	33-35	65
15	26-27	38-41	34-35	45-46	23-25	21-22	31-32	60
14	25	34-37	33	44	20-22	19-20	29-30	55
13	24	29-33	31-32	43	16-19	17-18	27-28	50
12	22-23	25-28	29-30	42	14-15	15-16	25-26	45
11	20-21	22-24	27-28	41	10-13	13-14	23-24	40
10	18-19	19-21	25-26	40	8-9	11-12	21-22	35
9	16-17	16-18	23-24	38-39	5-7	9-10	19-20	30
8	13-15	14-15	21-22	36-37	3-4	7-8	17-18	25
7	9-12	11-13	19-20	35	2	5-6	16	20
5-6	5-8	8-10	16-18	33-34	1	2-4	13-15	15
3-4	1-4	5-7	13-15	30-32	—	1	11-12	10
2	—	2-4	8-12	27-29	0	—	8-10	5
1	0	1	4-7	24-26	—	0	5-7	3
0	—	0	3-3	0-23	—	—	0-4	1
13.8	21.8	34.0	30.8	43.5	23.1	18.6	29.5	Mean
7.5	11.5	22.4	12.8	10.4	22.1	13.3	13.6	SD

N · 3200 ±

Raw Scores								
Num. Abil.	Abs. Reas.	Space Relo.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR+NA	Percentile
31+	42+	75+	44+	80+	89+	59+	59	99
28-30	40-41	68-74	38-43	71-79	81-88	51-58	55-58	97
26-27	37-39	62-67	35-37	65-70	73-80	46-50	50-54	95
24-25	35-36	55-61	32-34	62-64	65-72	42-45	46-49	90
22-23	33-34	50-54	30-31	60-61	60-64	39-41	43-45	85
20-21	31-32	46-49	28-29	58-59	54-59	37-38	41-42	80
19	30	42-45	26-27	56-57	49-53	34-36	39-40	75
18	29	38-41	24-25	55	45-48	32-33	37-38	70
17	27-28	35-37	23	54	41-44	30-31	35-36	65
16	26	32-34	21-22	52-53	37-40	28-29	33-34	60
15	24-25	29-31	20	51	33-36	26-27	31-32	55
14	23	25-28	19	50	29-32	24-25	29-30	50
13	21-22	23-24	17-18	49	26-28	22-23	27-28	45
12	19-20	20-22	16	48	22-25	20-21	25-26	40
11	17-18	17-19	15	46-47	18-21	18-19	23-24	35
10	15-16	15-16	13-14	45	15-17	16-17	21-22	30
9	12-14	13-14	12	43-44	11-14	14-15	19-20	25
8	8-11	11-12	10-11	41-42	7-10	12-13	18	20
6-7	5-7	8-10	8-9	39-40	3-6	9-11	16-17	15
5	1-4	5-7	4-7	36-38	0-2	5-8	14-15	10
3-4	—	2-4	2-3	32-35	—	2-4	11-13	5
1-2	0	1	1	29-31	—	1	7-10	3
0	—	0	0	0-28	—	0	0-6	1
14.5	21.2	29.5	19.2	50.1	33.1	25.0	30.5	Mean
7.1	11.5	19.3	10.1	10.9	24.3	13.8	13.1	SD

* Table 4.7 shows the study's Sex-by-Grade Norms of Numerical Ability, Abstract Reasoning & Verbal Reasoning

** With Courtesy from Manasayan, Delhi (India) for The Psychological Corporation, New York, U.S.A.

FORM **A** GRADE **9**

BOYS

N = 6900

Percentile	Raw Scores: Verb. Reas.	Num. Abil.	Abs. Reas.	Space Rela.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR + NA	Percentile
99	41+	35+	44+	87+	60+	73+	90+	59+	66	99
97	36-40	32-34	41-43	81-86	56-59	66-72	80-89	52-58	62-65	97
95	33-35	30-31	39-40	75-80	53-55	62-65	72-79	47-51	57-61	95
90	30-32	27-29	37-38	69-74	50-52	59-61	63-71	42-46	52-56	90
85	27-29	25-26	35-36	64-68	48-49	57-58	56-62	38-41	48-51	85
80	25-26	23-24	34	60-63	46-47	55-56	51-55	35-37	46-47	80
75	24	22	32-33	56-59	44-45	53-54	47-50	33-34	45	75
70	22-23	21	31	53-55	42-43	52	42-46	31-32	42-44	70
65	21	19-20	30	49-52	41	51	38-41	29-30	39-41	65
60	19-20	18	29	45-48	39-40	50	34-37	27-28	37-38	60
55	18	17	27-28	41-44	37-38	48-49	31-33	25-26	35-36	55
50	17	16	26	37-40	35-36	47	26-30	22-24	33-34	50
45	16	15	24-25	33-36	34	46	23-25	20-21	31-32	45
40	15	14	23	29-32	32-33	44-45	20-22	18-19	29-30	40
35	14	12-13	21-22	25-28	30-31	43	16-19	16-17	26-28	35
30	13	11	19-20	21-24	28-29	42	13-15	14-15	24-25	30
25	12	10	16-18	17-20	26-27	40-41	9-12	12-13	22-23	25
20	10-11	9	13-15	14-16	23-25	38-39	6-8	9-11	21	20
15	9	7-8	9-12	11-13	20-22	36-37	2-5	6-8	18-20	15
10	7-8	5-6	4-8	7-10	16-19	33-35	1	2-5	15-17	10
5	6	3-4	1-3	3-6	11-15	30-32	—	1	11-14	5
3	4-5	1-2	0	1-2	7-10	26-29	0	0	8-10	3
1	0-3	0	—	0	0-6	0-25	—	—	0-7	1
Mean	15.2	16.3	24.1	39.1	34.9	47.0	31.1	23.7	34.6	Mean
SD	6.7	8.2	11.3	23.4	12.6	10.5	24.1	14.6	14.6	SD

GIRLS

N = 740

Percentile	Raw Scores: Verb. Reas.	Num. Abil.	Abs. Reas.	Space Rela.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR + NA	Percentile
99	42+	34+	44+	81+	47+	82+	94+	67+	66	99
97	37-41	31-33	41-43	73-80	42-46	76-81	87-93	59-66	61-65	97
95	33-36	29-30	39-40	66-72	38-41	71-75	81-86	54-58	56-60	95
90	30-32	26-28	37-38	60-65	35-37	67-70	75-80	50-53	52-55	90
85	28-29	24-25	35-36	55-59	33-34	65-66	70-74	47-49	49-51	85
80	26-27	23	33-34	51-54	31-32	63-64	66-69	44-46	47-48	80
75	24-25	21-22	32	47-50	29-30	61-62	62-65	41-43	44-46	75
70	22-23	20	30-31	44-46	27-28	59-60	58-61	39-40	41-43	70
65	21	19	29	41-43	26	58	54-57	37-38	39-40	65
60	20	18	28	37-40	24-25	56-57	51-53	35-36	37-38	60
55	19	17	26-27	34-36	23	55	47-50	33-34	35-36	55
50	17-18	16	25	30-33	21-22	54	43-46	31-32	33-34	50
45	16	15	23-24	28-29	20	53	40-42	29-30	31-32	45
40	15	14	21-22	25-27	19	52	36-39	27-28	29-30	40
35	14	13	19-20	22-24	17-18	51	32-35	25-26	27-28	35
30	13	11-12	17-18	19-21	16	49-50	27-31	23-24	24-26	30
25	12	10	14-16	16-18	14-15	47-48	23-26	20-22	22-23	25
20	11	9	11-13	14-15	12-13	45-46	18-22	17-19	21	20
15	10	7-8	7-10	10-13	10-11	43-44	13-17	14-16	19-20	15
10	8-9	5-6	3-6	7-9	7-9	40-42	6-12	10-13	16-18	10
5	6-7	3-4	0-2	3-6	4-6	36-39	1-5	6-9	13-15	5
3	5	1-2	—	1-2	1-3	31-35	0	1-5	8-12	3
1	0-4	0	—	0	0	0-30	—	0	0-7	1
Mean	18.7	16.1	23.1	33.8	21.9	54.4	44.0	31.6	34.8	Mean
SD	5.6	7.8	11.6	20.3	10.5	11.3	24.8	15.1	14.2	SD

FORM A GRADE 10

BOYS

N = 3400 ±

Percentile	Verb. Reas.	Num. Abil.	Abs. Reas.	Space Rela.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR + NA	Percentile
	Raw Scores									
99	45+	36+	46+	91+	62+	85+	94+	68+	77+	99
97	42-44	35	44-45	87-90	60-61	72-84	87-93	60-67	71-76	97
95	38-41	32-34	42-43	82-86	57-59	67-71	82-86	55-59	65-70	95
90	35-37	30-31	40-41	76-81	54-56	63-66	74-81	49-54	61-64	90
85	33-34	28-29	38-39	72-75	52-53	61-62	68-73	46-48	57-60	85
80	31-32	26-27	36-37	68-71	50-51	59-60	63-67	43-45	55-56	80
75	29-30	25	35	65-67	48-49	57-58	58-62	40-42	53-54	75
70	28	23-24	34	62-64	47	56	53-57	38-39	50-52	70
65	26-27	22	33	58-61	45-46	55	49-52	36-37	47-49	65
60	25	21	31-32	55-57	44	53-54	45-48	34-35	45-46	60
55	24	19-20	30	51-54	42-43	52	41-44	32-33	43-44	55
50	22-23	18	29	47-50	41	51	36-40	30-31	40-42	50
45	21	16-17	28	43-46	39-40	50	32-35	28-29	37-39	45
40	19-20	15	26-27	38-42	37-38	49	28-31	25-27	34-36	40
35	18	14	24-25	32-37	35-36	47-48	24-27	23-24	32-33	35
30	16-17	13	22-23	27-31	33-34	45-46	20-23	21-22	29-31	30
25	15	11-12	20-21	22-26	31-32	44	16-19	18-20	27-28	25
20	14	10	17-19	18-21	28-30	42-43	11-15	15-17	25-26	20
15	12-13	8-9	14-16	13-17	25-27	40-41	6-10	11-14	23-24	15
10	9-11	6-7	7-13	9-12	20-24	36-39	2-5	7-10	19-22	10
5	7-8	3-5	2-6	4-8	15-19	33-35	1	2-6	14-18	5
3	5-6	1-2	1	1-3	12-14	29-32	0	1	9-13	3
	0-4	0	0	0	0-11	0-28	—	0	0-8	1
Mean	[illegible]	16.2	27.0	46.0	39.6	51.2	39.4	30.3	40.9	Mean
SD	[illegible]	[illegible]	11.2	25.0	12.5	11.4	26.3	15.9	16.8	SD

GIRLS

N = 3650 ±

Percentile	Verb. Reas.	Num. Abil.	Abs. Reas.	Space Rela.	Mech. Reas.	Clerical S and A	LU-I: Spell.	LU-II: Sent.	VR NA	Percentile
	Raw Scores									
99	[illegible]	36+	45+	85+	50+	97+	96+	73+	73	99
97	42-44	33-35	43-44	78-84	45-49	83-96	91-95	67-72	69-72	97
95	38-41	31-32	41-42	72-77	41-44	76-82	88-90	62-66	63-68	95
90	35-37	28-30	39-40	66-71	38-40	73-75	83-87	57-61	59-62	90
85	32-34	26-27	37-38	61-65	36-37	70-72	79-82	54-56	55-58	85
80	30-31	24-25	35-36	58-60	34-35	68-69	75-78	51-53	53-54	80
75	29	[illegible]	[illegible]	54-57	[illegible]	66-67	71-74	48-50	51-52	75
70	27-28	22	33	50-53	30-31	64-65	69-70	46-47	48-50	70
65	26	21	31-32	46-49	29	62-63	65-68	44-45	46-47	65
60	24-25	19-20	30	43-45	27-28	61	61-64	42-43	43-45	60
55	23	18	29	40-42	26	60	58-60	40-41	41-42	55
50	21-22	17	28	36-39	24-25	58-59	54-57	38-39	38-40	50
45	20	16	26-27	33-35	23	57	50-53	36-37	36-37	45
40	19	15	24-25	30-32	21-22	56	46-49	33-35	34-35	40
35	17-18	14	22-23	26-29	20	54-55	42-45	31-32	31-33	35
30	16	12-13	20-21	23-25	18-19	53	38-41	28-30	28-30	30
25	15	11	17-19	19-22	16-17	52	34-37	26-27	26-27	25
20	14	10	13-16	15-18	14-15	50-51	28-33	23-25	25	20
15	12-13	8-9	9-12	12-14	12-13	47-49	21-27	20-22	23-24	15
10	10-11	6-7	4-8	9-11	9-11	44-46	12-20	15-19	19-22	10
5	8-9	4-5	1-3	5-8	5-8	40-43	4-11	10-14	15-18	5
3	6-7	1-3	0	1-4	2-4	35-39	1-3	4-9	11-14	3
1	0-5	0	—	0	0-1	0-34	0	0-3	0-10	1
Mean	22.4	17.3	25.4	38.4	24.6	59.2	52.7	38.0	39.7	Mean
SD	9.5	8.3	12.0	21.7	11.0	12.3	25.0	16.0	16.0	SD

APPENDIX D

PLANNED DATA ANALYSIS : USING COMPUTER FACILITIES

Serial Number — **Instructions ***

1. **Calculation of:** Mean, Median, Mode and Standard Deviation for variables :
   (a) 007; 008; 009; 010; 011
   (b) 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022, 023 and 024.

2 (a) **Calculation of:** total items, scored right, as well as wrong, for variables:
012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022, 023.

(b) **Calculation of:** the number of cases of persons answering each item correctly, and persons not answering each item correctly, for the following 69 variables:
025, 026, 027, ... 090, 091, 092, 093

3. **Calculation of:** Mean and S.D. for variables:
007, 008, 009, 010, 011, 012, 020, 021, 022, 023, 024,
   (a) sexwise
   (b) agewise
   (c) Gradewise
   (d) with respect to father's occupation
   (e) with respect to mother's occupation.

4. **Calculation of** correlation coefficients for variables:
   (a) 007, 008, 009, 010, 012, 013, 014, 015, 016, 017, 018, 019, 020, 021, 022, 023
   (b) 025, 026, 027, ... 090, 091, 092, 093.

5. **Calculation of:** 't' tests involving the following variables, 007, as well as, 008; contrasting them, with groups in variables, 001, 002, 003, 005, as well as, 006, in the order:

(a) Independent variable; 001 (1. Female & 2. Male)
Dependent variable (1): 007 (Intelligence Test) &
Dependent variable (2): 008 (Numerical Ability Test)

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*Table 3.[illegible] shows the full list of Variables of the Study (whose Computer Code Numbers, in three digits should read as: 001, 002, 003.... to 093).

(b) Independent variable, 002 (Ages of Females & Males of variable 002, categories: 1,2,3)
Dependent variable (1): 007 (Intelligence Test), &
Dependent variable (2): 008 (Numerical Ability Test)

(c) Independent variable; 003 (Grades of Females & Males of variable 003, categories: 1,2,3):
Dependent variable (1): 007 (Intelligence Test), &
Dependent variable (2): 008 (Numerical Ability Test)

<u>The within Groups Set-up</u>

(i) Group 1 (VAR 001) at Group 1 (VAR 002) } with { Group 1 (VAR 001) at Group 3 (VAR 002)

(ii) Group 2 (VAR 001) at Group 1 (VAR 002) } with { Group 2 (VAR 001) at Group 3 (VAR 002)

(iii) Group 2 (VAR 001) at Group 1 (VAR 002) } with { Group 2 (VAR 001) at Group 3 (VAR 002)

(iv) Group 1 (VAR 001) at Group 2 (VAR 002) } with { Group 1 (VAR 001) at Group 3 (VAR 002)

(v) Group 2 (VAR 001) at Group 2 (VAR 002) } with { Group 2 (VAR 001) at Group 3 (VAR 002)

<u>Calculation of</u> 't' tests for variables :
012, 013, 014, 015, 016, 017, 018, 019, 020,
021, 022, 023, 024

(b) Independent variable, 002 (Ages of Females & Males of variable 002, categories: 1,2,3)
Dependent variable (1): 007 (Intelligence Test), &
Dependent variable (2): 008 (Numerical Ability Test)

(c) Independent variable; 003 (Grades of Females & Males of variable 003, categories: 1,2,3):
Dependent variable (1): 007 (Intelligence Test), &
Dependent variable (2): 008 (Numerical Ability Test)

<u>The within Groups Set-up</u>

(i)	Group 1 (VAR 001) at Group 1 (VAR 002)	with	Group 1 (VAR 001) at Group 3 (VAR 002)
(ii)	Group 2 (VAR 001) at Group 1 (VAR 002)	with	Group 2 (VAR 001) at Group 3 (VAR 002)
(iii)	Group 2 (VAR 001) at Group 1 (VAR 002)	with	Group 2 (VAR 001) at Group 3 (VAR 002)
(iv)	Group 1 (VAR 001) at Group 2 (VAR 002)	with	Group 1 (VAR 001) at Group 3 (VAR 002)
(v)	Group 2 (VAR 001) at Group 2 (VAR 002)	with	Group 2 (VAR 001) at Group 3 (VAR 002)

A- Gradewise (i.e. Among Groups comparison) of:

(a) Group 1 (VAR 003) with Group 2 (VAR 003);
(b) Group 1 (VAR 003) with Group 3 (VAR 003) and
(c) Group 2 (VAR 003) with Group 3 (VAR 003).

B- Grade and Agewise (i.e. within Groups comparison) of:

(a)	Group 1 (VAR 003) at Group 1 (VAR 002)	with	Group 1 (VAR 003) at Group 2 (VAR 002)
(b)	Group 1 (VAR 003) at Group 1 (VAR 002)	with	Group 1 (VAR 003) at Group 3 (VAR 003)
(c)	Group 1 (VAR 003) at Group 1 (VAR 002)	with	Group 2 (VAR 003) at Group 1 (VAR 002)
(d)	Group 1 (VAR 003) at Group 1 (VAR 002)	with	Group 3 (VAR 003) at Group 1 (VAR 002)

C- Grade and Sexwise (i.e. within Groups comparison)of:

(a)	Group 1 (VAR 003) at Group 1 (VAR 001)	with	Group 2 (VAR 003) at Group 1 (VAR 001)
(b)	Group 1 (VAR 003) at Group 1 (VAR 001)	with	Group 3 (VAR 003) at Group 1 (VAR 001)
(c)	Group 2 (VAR 003) at Group 1 (VAR 001)	with	Group 3 (VAR 003) at Group 1 (VAR 001)

D- <u>Occupation wise</u>: (Father & Mother occupations)
Among : VAR 005 with VAR 006 in the order :
If category 1 (VAR 005) = Category 1 (VAR 006);
then test against the rest combined, of VAR 005
(Categories 2, 3, 4, & 5) and VAR 006 (Categories
2, 3, 4, & 5).

7. <u>Calculation of Factorial Analysis in the order of</u>:

(a) Estimates of communalities in each of the twelve schemes of thought problems, and four psychological tests;

(b) Thought problems, and four psychological tests (their Common Factors, and Eigen Values, as well as, Percent of Variances, and Comulative Percentages);

(c) Original Factor Loadings, as well as, Varimax Rotated Loadings in variables :
007, 008, 009, 010, 012, 013, 014, 115, 016
017, 018, 019, 020, 021, 022, 023.